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WORKS PRODUCTION.

THE timely and interesting paper read by Mr. G. H. Nelson before the Institution of Electrical Engineers on January 18th, 1923, and summarised in our last issue, should be carefully read and acted upon by all those who have anything to do with the manufacture of engineering products. As an indication of what is being done by one of the largest of our British firms it is of value; and the fact that, as Mr. Nelson acknowledges, the methods described have been in practical use by the Metropolitan-Vickers Electrical Co., Ltd., for some time, makes it certain that here we have no mere theorising, no armchair idealism, but a sound contribution, drawn from the well of experience, to the knowledge of the problem. The freedom with which the firm's methods are disclosed to all who are interested is, we hope and believe, a sign of the times. Those who have the interests of the nation at heart should realise that the times of elaborate secrecy have gone by. The worst-organised undertakings must emulate the best-organised, and the best-organised must strive after improvement.

Lord Milner has stated in *The Observer* that Labour has noted that "vastly improved powers of production fail to result in any corresponding increase of general well-being." That this is only too true no one will be disposed to deny, but that is not to say that methods of improving the powers of production of manufacturing undertakings are in themselves a mistake. It must not be forgotten that with less knowledge of, and advancement in, methods of production, the position of the wage- and salary-earning community would be worse, and not better; and in addition we should probably have lost the war. The paper now before us is only intended to deal with the problem of improvement as it affects the manufacturer's works, and, as the author is careful to state in his summary, those with which he has himself been associated. If this is borne in mind, criticism based upon the political aspect of the problem of buying, selling, and manufacturing will be found to be misdirected.

Dealing then with the problem of how to get the best results out of a factory laid out for the production of a definite class of machinery, Mr. Nelson shows in his paper, and showed in greater detail at the meeting by means of lantern slides (which we hope will be reproduced as far as possible in the *Journal*), the varied and numerous considerations which must be taken into account if the highest efficiency is to be obtained. Our readers are aware that we have lately laid stress on the necessity for the establishment and proper carrying-on of process, production, and inspection departments; and we had intended to discuss, at an early date, the no less important question of works costing. The section of the paper dealing with this matter is, perhaps, one of the most useful. Mr. Nelson says that he "has experienced great difficulty in cases where costs are not available until a machine is finally completed." What an eye-opener such a statement must be to the old-fashioned works in which costs are not only not available until the machine is fully completed, but virtually not available until the end of the financial year, and of precious little use when they have been calculated! No doubt the Metropolitan-Vickers Company will be the first to admit freely that it was not always as well organised and equipped in this direction as it is to-day. For instance, we do not think we are mistaken in believing that the machine-rate basis has only superseded the percentage on labour, as the method of com-

puting factory overhead expenses, within quite recent years. But now that the results of the company's experience are available it should not be difficult for others to follow its example. The important point is brought out that, in Mr. Nelson's opinion, arrived at after personal inspection, the United States of America has nothing to show which could improve the organisation outlined in his paper for handling a varied product. It is most desirable that production costs, which are, or ought to be, the records of a firm's own experience, should be capable of adjustment to meet the changing conditions of the markets, whether of raw material, of labour, or of the sale of the product when finished. Accurate and up-to-date knowledge on this subject would be exceedingly useful in the establishment of what may be described as "associated prices," and would help to prevent those wild stabs in the dark which frequently surprise those whose province it is to notice them, and not least, it is probable, their proposers. The export market cannot be properly handled at all without such knowledge.

We are of opinion that the selling expenses are overstated in the tables showing the relation between output and costs of production. It depends on what class of machine is being handled, but 25 per cent. seems a great deal. Large machinery bears a value which should reduce this percentage, while small repetition products should cost less to sell than is indicated by such a figure. If 25 per cent. includes directors, management, accounting and collecting, as well as the salaries and expenses of the sales offices, it is perhaps reasonable, though it ought, we think, to be capable of being reduced. We are glad to note that Mr. Nelson appears to appreciate the need for the co-operation of the sales and design departments in order to secure the most satisfactory handling of the problems before any manufacturing firm. Here, as in most cases, extremes are to be avoided. On the one hand, there are still too many buyers who, ignoring the existence of the B.E.S.A., or perhaps endeavouring to improve upon its work, insist on drawing up elaborate specifications to show manufacturers how to carry out their work, while on the other we are still not entirely free from the type of manufacturer who says to his sales staff: "That's what we make—sell it!"

We hope that other engineers will be tempted to follow Mr. Nelson's example, and tell us of their experiences.

The Coming Electrical Exhibition.

Notwithstanding all that we have said in these pages regarding the immensity of the exhibition enterprise to which the electrical industry has pledged itself for next year, it is doubtful whether the reader has yet allowed his imagination so to visualise the project as fully to conceive what the complete undertaking will be like. Certainly the more one tries to grasp the details, the clearer does it become that we have never yet witnessed anything like it in connection with British electrical engineering. Many years have elapsed since our organised electrical industry produced its last large-scale display, and during the intervening period the capacity, and in some respects the character, of the industry have greatly changed owing to the progress and development that occurred during the years of war. The industry is larger, greater, and more efficient altogether than it was when we all co-operated in securing successes at Olympia and Manchester, and it is entering upon an enterprise in which will be represented and reflected all the inventive ingenuity, industrial and financial capacity and strength that have made British electrical engineering what it is to-day. In the coming months it will be our duty to draw attention to special aspects of the Exhibition scheme, which will make the domestic appeal for which electricity is so highly qualified, as well as the large demonstration of plant such as will be present on many a stand, in addition to the £130,000 temporary power station and sub-station equipment. Between the smallest and the largest example to be exhibited is a great range of a thousand products, and the makers of Anything Electrical will be wise to consider their position in relation to the show, as well as those who are makers of Everything Electrical. We may direct our readers' attention to the first of a series of official electrical announcements relating to the exhibition which appears in our other pages to-day. As stated there, more than 60,000 square feet of exhibiting space—that is more than half of the space allotted to the electrical industry—has been taken up. We understand that all applicants for space, whether members of the B.E.A.M.A. or not, are now being treated on precisely the same footing as regards price and position, according to the order in which applications are lodged. We trust that the whole of our British manufacturers will speedily resolve to contribute their share of effort to ensure the completeness of the display, both in their own individual interest and for the good of the industry as a whole. In any case the industry has a great and grand future in store; the exhibition is bound so to impress the world as to hasten the period of unparalleled prosperity.

Belated Government Reports.

Manufacturers and shippers of electrical machinery and apparatus had been wondering when the final volumes of the "Annual Statement of the Trade of the United Kingdom for 1921" might be expected to make their appearance. Whether it be due to the Geddes "axe" or other reason, the publication of this Blue Book, for which the Board of Trade is responsible, has become so belated that its use to British manufacturers is largely depreciated. As is generally known, the monthly returns relative to imports and exports issued by the Board of Trade are mainly confined to gross *totals* (quantities and values), the details of the trade with particular countries not being available until the Annual Statement is issued.

Prior to the war the Statement usually made its appearance in July or August. For some years, however, the date of issue has gradually become later and later, with the result that it is only now, when we are in the year 1923, that the final three volumes for 1921 are available. To be of value to British industry generally, and so to warrant the heavy financial outlay the compilation of the Annual Statement must entail, we certainly think an endeavour should be made to issue the return for one year before the close of the next. The delay which has taken place in this case has, we understand, been brought to the notice of the Federation of British Industries, so that we are hopeful of pressure being brought on the Government Department in the direction of speeding up the production of this and other official Blue Books, the value of which, as we have said, largely depends on the celerity with which they can be issued.

London's Electricity Supply.

The particulars which we give elsewhere in this issue regarding the Bill promoted by the London Electricity Joint Committee (1920), Ltd., seem to indicate a disposition on the part of this company to take the matter of London's electricity supply into its own hands, so far as concerns the areas at present supplied by companies. The Bill, if enacted, would confer upon it all the necessary powers for that purpose, and, further, would apparently authorise it to purchase and take over the undertakings of any authorised undertakers, including those of local authorities, if the owners were willing to part with them. So far as London is concerned, it would appear that the company desires to be armed with the powers of a Joint Electricity Authority itself, at least in respect of the areas in which its constituents have powers to supply electricity. The suspension of the rights of purchase

held by the County Council or any other body is contemplated, and apparently every one of the Electric Lighting Acts will be more or less modified in its application to the company's undertaking if the Bill becomes law.

In a word, this company of limited companies seeks authority to become the company charged with the duty of supplying electricity to as much of the metropolitan area as it can get hold of, including both generation and distribution. We must confess that the idea is attractive. It could have been achieved years ago if its members had joined hands instead of supporting the opposition to the various attempts that were made to unify the supply of London. Our sympathies are with the companies, which were the pioneers of electricity supply and had to battle for existence in the early days, and we should be glad to see them established on a new and profitable basis, with extended tenure and a sliding scale of dividends and prices as contemplated in the Bill and in the scheme formulated by the Electricity Commissioners.

What we are strenuously averse to is the prolongation of the existing situation. Admitting the difficulties that the companies have laboured under, and the restrictions imposed upon them by the pending purchase and other statutory provisions, and without seeking to indict them for what they cannot help, the fact remains that they are beaten by the larger municipal undertakings of London both in prices charged and enterprise of management. Reform is badly needed; we have seen at Paris what can be done by co-operation on the part of the companies towards the centralisation of generating plant and the unification of supply, and we want to see the same principles applied in London.

Underground Cable at 100,000 Volts.

From time to time proposals are put forward for improving the efficiency or reducing the cost of electrical systems and apparatus which involve considerable departures from current practice. Such schemes should receive most careful consideration, for we cannot afford to miss any opportunity of making progress in electrical technology. The conservatism which is inherent in mankind, and which is perhaps somewhat more deeply rooted in the British temperament than in that of some of our competitors, causes us to look askance or at least with a severely critical eye on such proposals, especially if they appear to add to the complexity of the existing systems; but the pathway to simplicity often lies through initial complexity, and even if a scheme is open to that criticism, it may contain the germ of a fundamental idea from which great consequences may result.

We are prompted to these reflections by the remarkable paper which Major A. M. Taylor recently read before the Institution of Electrical Engineers—a paper which, it must be admitted, is difficult to understand, but which puts forward claims for economies so great that it behoves us to regard his proposals very seriously. Major Taylor, whose industry and imagination command our admiration, has evolved a scheme for working underground cables at 100,000 or even 150,000 volts, alternating—a very different matter from the direct-current problem, which involves no serious difficulty. His scheme comprises a special transformer arrangement and a special cable system. The double-star connection may serve for the transformers, but the proposed cable system remains special. The relative advantages of the transformers and different connections for stepping-up to the required cable voltage would appear to be a problem independent of that of the cable itself. The proposed type of cable and the advantages claimed for it by the author seem to be so exceptional that, in its present state, the problem is one for the cable makers to investigate. Before any maker can take up the manufacture of a cable of this type, he must needs satisfy himself as to the saving in cost and the other merits ascribed to it by the author, apart from the question of possible difficulties in manufacture, &c.

Cable makers are certainly on the look-out for a cable that will give a saving of something like £750,000 in cable cost when transmitting 100,000 kW, or £7 10s. per kW transmitted—the saving claimed by Major Taylor in a case to which he refers. In another important claim, Major Taylor states that, by the use of his cable scheme, an increase of roughly 100 per cent. can be made in the voltage applied, for a given depth of insulation, and that this enables the current density to be doubled, while the cross-section of the conductor is reduced to one quarter. In view of these remarkable statements, there would seem to be ample justification for a careful investigation and analysis of the proposal. Several schemes for intersheath cable have been proposed, and Major Taylor's paper is of a kind to foster research and study in that direction.

Britain and Brazil.

Some strange anomalies exist in the commercial relationship between Brazil and Great Britain. In the past that country has obtained finance and technical guidance from the United Kingdom in the development of its resources and the establishment of public utilities. More help of each kind is still needed, but present conditions in that great and only partly-exploited South American Republic render it doubtful what return will be forthcoming in the near future on any further assistance proferred. As regards investment of British capital in railways, &c., H.M. Commercial Secretary at Rio de Janeiro says in a report which we summarised last week that recent years have unfortunately proved the increasing difficulty for such capital to earn interest for the investor. That official does not attempt to define in detail the causes of this difficulty. It is felt, he says, that the extent to which Brazil depends and must depend for its development on the application of foreign capital in the country has not been fully realised, and that tangible proofs of the Brazilian Government's readiness to guarantee foreign capital employed in Brazil must be definitely secured if further capital is to be attracted to the country. Meanwhile it is not surprising that the United States has come forward as a new market for supplying loans to the Brazilian Government and the various Brazilian States and municipalities. New York has not, however, rushed forward in the guise of the man with pockets full of "money to burn." The Commercial Secretary states succinctly, "Ample guarantees have been exacted," and records the opinion that it will be difficult for Brazil to obtain from other lenders the same tolerant treatment that has invariably been shown to her in London in financial matters. The question therefore arises: Why does Brazil persist in granting preference to certain imports from the United States and Belgium, whilst refusing similar favours to British goods?

More Trade Commissioners.

In view of our recent comments on the need for more British Government Trade Commissioners in overseas markets, we note with satisfaction that the Department of Overseas Trade is inviting applications from candidates for two additional Trade Commissioner appointments in India. The gentlemen selected are to be stationed at Calcutta and Bombay respectively. An ability to speak Hindustani is one of the stipulated qualifications, as is also, and quite naturally, a first-hand knowledge of conditions in India, but there are many unspecified essentials, and we are not sure that the salary of £800 and allowances will attract men of suitable status and responsibility. For the present the posts will be temporary, but we hope that when their permanent establishment comes under consideration, as it is to do at a later date, the success attending the temporary efforts will be such that the permanency of fuller representation in so important a market will be settled with little hesitation.

WATER-POWER STUDIES.—I.

Pressure Pipe Lines.

By WILLIAM T. TAYLOR, M.Inst.C.E., M.I.E.E., M.Am.Soc.C.E.

This article commences a series on "Water Power Studies," by Mr. Taylor. They will appear in the order of: (1) Pressure Pipe Lines; (2) Developed Waterways (conduits); (3) Stream Flow; (4) Storage and Pondage; (5) Rainfall and Run-off; (6) Reporting on a Water-power Project. Instead of commencing with the catchment area, the author considers that it will be more interesting to the engineer interested in hydro-electric practice if the series starts at, though not including, the power house.—Eds. Elec. Rev.

In attempting to describe certain aspects of the most economical electrical transmission line design*, the writer pointed out the unnecessary step of seeking extreme refinement in the calculations when the problem is based on a *fixed* set of assumptions as to the power, time-period, diversity of peak loads, power factor, specific cost of energy, and other considerations, all of which are more or less variable. A pipe line or penstock design is based on almost the same general theory. In the one case, the typical problem presented is: (*a*) Given a transmission line of fixed length, given voltage and given power, it is required to determine the size of the line so that for a given or assumed power loss in the transmission system the annual cost of the transmission system will be a minimum. And in the other case, the typical problem is: (*b*) Given a pipe line of fixed length working under a given static head with a given discharge, it is required to determine the size of pipe so that for a given or assumed power loss in the pipe line the annual cost of the pipe will be a minimum. Of the two, a much greater margin can be allowed in the latter.

In this text *riveted steel pipe* is the only class considered. For all ordinary pipe-line design the working stress s in lb. per square inch quite often allowed is 9,000, but where there is a danger of water hammer, this working stress may be reduced. This value s (9,000 lb. per sq. in.) and joint efficiency e of 100 per cent. form the basis of fig. 2†; for other values, multiply H values in diagram by $s\,e/9{,}000$. Steel pipes are made of rolled plate, riveted together or lap welded. Lap joints are made single, double and triple riveted, according to the static head. Butt strap joints are made double, triple and quadruple. The lower sections of pipe lines working under high head may be of butt strap riveted pipe, or of seamless welded pipe; the latter pipe is used to avoid additional loss of head that would be caused by the riveted pipe which has a greater number of rivets in the lower sections; the use of welded pipe has been retarded mainly because of uncertainty of weld. Steel plates can be obtained in steps of 1/16 in. thickness. In making the design, 1/16 in. is usually added to the calculated thickness. The minimum thickness of shell advisable is ordinarily between $\frac{1}{4}$ and $\frac{1}{2}$ in.; the actual thickness is, of course, proportional to the diameter of the pipe. Steel pipe has an expansion of about $\frac{3}{4}$ in. per 100 ft. per 100 deg. F. For a straight steel rigidly held pipe line located above ground, expansion joints are usually required. Masonry pipe-line supports are often damaged by expansion and contraction of the pipe where adequate expansion joints are not employed; to avoid this trouble they are placed underground, or steel piers (set in concrete in masonry bases or in rock foundations) are employed, and an expansion joint is suitably fitted. Much importance is attached to the location, laying, and anchoring of a pipe line. The bottom end of the pipe line should be held securely to prevent forces due to temperature changes and other causes from throwing the turbine out of alignment. The gradient of a pipe line is rarely uniform. When a pipe line is laid for a considerable distance on a very slight gradient and then descends to the power house on a steep grade, it is liable to collapse because the water flowing through the steep grade of pipe line will have a tendency to increase its speed more quickly than the water in that part on the slight gradient; an air-valve or standpipe (preferably the latter) may be necessary in such cases; its location would be at the junction of the two gradients. All points of a pipe line should be well below the hydraulic gradient, otherwise the pipe may not stand a heavy overload without danger of the water column parting on the summit. The pipe should be laid in the shortest distance to the power house and in such a manner as to avoid sharp angles, sudden changes in gradient, and abrupt changes in area. The value of the coefficient of roughness η of pipe is generally between 0.010 and 0.015; with corrosion and tuberculation, the value of η may rise to 0.020 or even more, hence, the head loss might be, and often is, appreciably greater for an old pipe than for a new pipe.

In medium and high head developments the final passage of the water before reaching the turbine is through penstocks or pressure pipes. The very low head developments are usually completed without penstocks or pipes,* as the turbines are fed directly from an open flume or forebay. In the ordinary low-head development a reinforced concrete pipe or concrete-lined circular tunnel is sometimes employed, but more often the steel pipe is used. For nearly all heads, *steel*, in preference to all other material, is generally employed for pipe lines. Hence the reason why this class of pipe, *i.e.*, lap riveted and butt strap riveted pipe, is the only class covered by the text. Of course we may use other joints, such as the "muff," "bump," flange, &c., but never the lead joint; much use has been made of the angle and other types of flange joints.

The purpose of a pipe line is to conduct and convey energy in the most efficient manner from the forebay or from the reservoir, diversion basin, or from the headrace to the power house and turbine under certain specified conditions; therefore it is important to locate, design, and construct the pipe line in the most reliable and economical manner. The importance is more intensified in a pipe line of great length in which the capital outlay is comparatively large with respect to the total cost of the development. As in the case of a determination of the most economical transmission line, it is equally evident that while the method of calculation remains true, industrial and financial conditions change the value of energy and the cost of the installation, &c., and the constants *assumed* in the calculation to determine the economical condition may differ at one time from those assumed at another time. The principle of economy in the determination of the economical size of pipe line for a hydro-electric plant may be, and sometimes is, different for different plants, differently situated and offering different characteristics. The economical design may take several different forms, depending on requirements and the economic aspect. For instance:—

(*a*) It may be required to develop so as to yield a maximum amount of power irrespective of first cost, because of an unlimited power market. In such a case, maximum efficiency is required, and the economical size of pipe would be that giving the least total loss of head. On the other hand:

(*b*) Due to conditions offered, we may find it better to develop the scheme so that the annual cost of operation

* Elec. Rev., August 8th, 1922.

† The figures will appear in the concluding instalment of the article.—Eds.

* Throughout the text the word "pipes" will be used in preference to the word "penstocks."

will be a minimum for a maximum output, and the annual net income a maximum. But:

(*c*) Where the working head and water supply are ample and the power market very limited (relatively so), then the lowest practicable minimum first cost per h.p. developed may be the best requirement. However:

(*d*) The usual requirement—where the amount of water available is limited—is to produce as much power as possible consistent with a fair return on the investment. Of course, when the water consumed has little or no value, it is allowable to employ the smallest diameter of pipe; the latter condition is normally not applicable to the text.

For low head installations the pipe line is usually made to consist of a constant diameter and thickness throughout. With medium head installations it is generally found more economical to make the pipe line consist of two or more sections, each section of the same diameter but different thicknesses of shell. With high head installations it is more economical to make the pipe line consist of several sections, each section of different diameter and different thickness of shell, as shown in *Example II.** The diameters of steel pipes (of varying thickness of shell) for high head installations vary nearly inversely as the 7th root of the head, *i.e.*, between 7.0 and 7.25. For low head, the diameter will vary nearly inversely as the 6th root of the head, *i.e.*, between 6.0 and 6.25. For high head installations it is generally found that much saving in metal and consequent cost can be made by tapering the diameter of the pipe in such a way that the total head lost in friction will be the amount considered permissible, rather than by selecting a uniform or constant diameter which will give the same total friction head loss. If in each section of a pipe line the diameter of pipe decreases as the corresponding thicknesses increase with increasing head, the pipe line will more nearly approach the theoretically most economical pipe line.

In the design, it is usually desirable to satisfy the commonly understood fundamental rules of economy by making a determination of the size of pipe so that the percentage return on the initial investment shall be a specified amount or a maximum, and so that the total net annual income shall be a *maximum*. Before designing a pipe line we require to know: (1) the general profile and topography of the site; (2) probable drainage modifications due mainly to the location of forebay spillway; (3) the character and conditions of hillside which must satisfy pipe anchorage and the most economical location of the forebay and the pipe line; (4) the head under which the pipe line is to operate; (5) the quantity of water available; (6) the length of sections and of pipe line; (7) best and most economical types of joints; (8) character of loads; (9) diversity of peak loads; (10) load factor and other considerations. The principal quantities to be determined—after selecting the site—are: (*a*) The economical diameters for the different sections along the pipe line; (*b*) selection of the best and most economical types of pipe joints; (*c*) the thicknesses of the different pipe sections. The effect of joint efficiency on economy is extremely important. Of all the joints in use there are six common types of riveted joints varying in efficiency from 57.7 per cent. up to 94 per cent. Pipe with welded longitudinal seams with either riveted or flanged circular joints has the advantage of minimum weight and low friction losses. Where reliable welding can be done, *the welded pipe is recommended for high head installations.*† In calculations where a formula is used for determination of economical diameter, the required diameter of the pipe is unknown, and must first be assumed; also, according to the head, various types of joints must be given, and allowance should be made for weight which does not vary at a uniform rate with the diameter of pipe, &c. It is considered by the writer that a graphical presentation would be more useful than the formula itself. In the first place, to determine the economical size of pipe it is usually necessary to calculate a series of pipes and determine which is the most economical. By formulæ this is tedious and perhaps uncertain, unless cross-checking of the calculations is done. By means of graphs or diagrams (such as those given herein) an error is visualised; furthermore, it is quite a simple matter first to select a number of possible diameters for a given rate of flow (q) with different assumed losses (*h*) and find *the* economical size from the diagrams. For a high head development the diameter would not be constant throughout the whole length, and therefore for a given loss at the start of the calculation it would be proportioned to different sections of the pipe line. Quite often the limitation of a minimum thickness of shell will indicate a pipe of large diameter at the top, thus allowing most of the total loss by friction to be at the lower end of the pipe line. Simply by the use of figs. 1 and 2* all these values can be set in profile, in tabular form or graphic form, and usually a more satisfactory solution can be obtained than by formulæ alone. As several different aspects of the same problem can be considered, it would seem better to lay out on paper one or several lines in profile (showing lengths, thicknesses and heads), then find the losses and costs from the diagrams, and from this information determine the most economical size. The design may seek equal strength at all points on the pipe line in respect of either a new pipe or an *old* pipe, that is to say, after a lapse of a period of years corresponding to the normal life of the pipe. The losses and cost to be accounted for would generally be (*a*) head loss resulting from the pipe friction to the flow—the entry head and velocity head usually being omitted; (*b*) size and weight of pipe; (*c*) annual value of head loss; (*d*) cost of the installed pipe complete; and (*e*) annual charges on the total investment. The annual interest and depreciation on the initial cost of any section of the pipe line would be proportional to the amount of metal in the section, *i.e.*, proportional to the length of section; the diameter of pipe; the head on the point under consideration, and a *constant*. The location and fixing of the most economical sections would depend largely on the hillside conditions, the geology and topography, and therefore they affect the economic problem.

In making the design, one of the first things to be done is to establish the relation between the cost and the several independent variables which are mentioned hereafter. The cost will have a minimum for a definite discharge and definite length by varying several of the independent variables. Should a pipe line of relatively large diameter be chosen for the purpose of increasing the efficiency of the pipe line, the value of the extra amount of power obtained due to this higher efficiency may not merit the increased investment. On the other hand, should a relatively small size of pipe be chosen for the purpose of reducing the annual charges on the investment, the resulting loss due to the lower efficiency of the pipe may more than offset this reduction in annual cost. The energy loss generally accounted for in a pipe-line design is composed of one factor, namely, the energy loss due to friction. This loss increases with the length of pipe, is inversely proportional to the diameter of the pipe, and it increases with the roughness of the interior surface of the pipe. In the economical design of a pipe-line system for a given flow, it is necessary to consider the number of pipes (separate pipe lines) and the amount of water which each pipe must be able to carry under specified conditions. For the larger schemes where large units are employed it is a common practice to have one pipe line for each turbine. The smaller installations usually cannot permit the expense of one pipe line per turbine, hence a "header" is employed.†

In a pipe-line design there are several independent

* See next issue.

† In "Water-Power Studies II" a logarithmic chart will be given for safe working head (*u*), thickness (*t*), and weight of pipe (*w*) for different diameters of welded pipe (using flange joints) and for heads of from 100 to 2,000 ft.

* See next issue.

† See "Hydro-Electric Development in Bolivia," Electrical Review, May 5th, 1922, p. 617.

variables that enter into the economic problem. They are: (1) Number of pipe lines; (2) length of pipe lines; (3) total head and head losses; (4) factor of safety allowed; (5) size of pipe section or sections; (6) thickness of pipe section or sections; (7) available quantity of water; (8) velocity of flow at normal and peak loads; (9) nature and amount of load; (10) selling price of energy; (11) allowance for interest and depreciation of the investment, &c. The principal factors depend on the quantity of water, the static head, the cost per lb. of metal, and the total cost of the development as a whole. These variable factors define the basis relating to the actual cost of a pipe line for a water-power scheme. On the other hand, the size and weight of pipe, and the discharge and velocity of water, relate to the economical design of a line (varying in respective ranges), and they may be taken as representative of the principal variables that govern the economical design.

The cost of a pipe line is dependent not only on the quality of metal and materials, but on their market conditions. Where conditions require that the factor of safety be very high and/or the market price for metal, &c., is very high, the cost of the completed pipe line may be excessive. Moreover, the annual cost of a pipe line is dependent not only on its original or its initial investment, but also on the coefficient representing interest and depreciation and other operating expenses. That is to say, a low investment may very quickly become a large cost item when the coefficient of annual expense is large on account of high maintenance costs, &c. When the pipe line is long, the cost due to the head loss and that due to the annual expense of the complete installation will tend to increase almost proportionally. For most pipe lines the former may be, and often is, the predominating factor of the first cost, that is, the cost due to the energy lost in the pipe line, and the variation and character of load will have a direct influence on the *most* economical design and on the total value (power loss value plus interest value). When the demand for power is small at low load factor, the economical design would indicate a smaller pipe than in a case where the demand for power is large at high load factor.

(To be concluded.)

WORKS PYROMETRY.

By "ELECTRON."

The mercury thermometer to-day is still the most widely used instrument for determining the lower temperatures, whilst modifications of it give fairly satisfactory results up to a temperature of some 600° C. This necessitates the filling of the capillary tube with an inert gas, such as nitrogen, instead of employing the more customary vacuum. Although these two types of thermometer are used for certain works purposes, they are at a great disadvantage owing to being made of glass. It is highly probable that glass possessing a certain amount of strength and ductility will ultimately be discovered, but

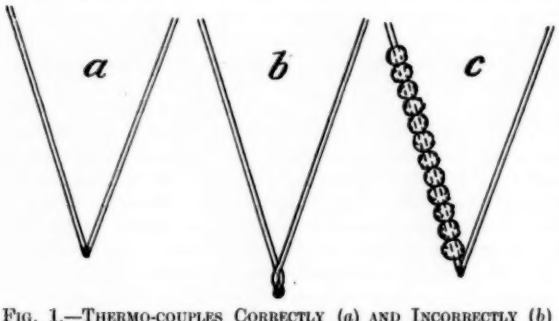


Fig. 1.—Thermo-couples Correctly (*a*) and Incorrectly (*b*) Joined; and (*c*) Insulated.

until this happens the thermometer will never be popular in iron and steel works, potteries, brass foundries, cement works, and the like. The thermo-electric pyrometer is the most widely used instrument to-day, and offers a practical works method of pyrometric control which can be safely carried out by any workman of average intelligence. We will consider this method from a practical utility standpoint, chiefly because the numerous electrical calculations involved may be obtained from any modern electrical text-book.

Couples.—Thermo-couples are usually made from either two dissimilar metallic wires or from one wire welded to a metallic sheath and suitably insulated from it. The type of couple used varies with the purpose it is to be used for, because some couples give a higher e.m.f. than others, whilst some couples are entirely unsuitable for certain purposes. It is essential that the e.m.f. produced in a couple should increase uniformly with increase of temperature; also, it is obvious that the melting-point of the components must be well above the maximum temperature to be measured, and furthermore the thermo-electric value must remain constant for a given temperature after prolonged heating and sudden cooling. Of course, sooner or later, all couples lose their thermo-electric value by repeated heatings and coolings owing to the crystallisation of the metals, oxidation, and so forth; but a couple with the longest possible life should always be chosen, whilst the precautions taken to avoid these causes of failure will largely determine the life of a couple.

Instruments.—The instruments used for indicating the e.m.f. generated in a couple may roughly be divided into two classes, which are indicators and recorders. The principle of these two classes of instruments is generally exactly similar, and recorders are usually merely indicators working in conjunction with a clock-work arrangement and with the substitution of a pen for a pointer which records the temperature at regular intervals on a chart. The moving-coil type of millivoltmeter is the most popular to-day, and the "pivoted" type is perhaps the best for general purposes. Base-metal couples which give a large e.m.f. give excellent results with these instruments, which are comparatively cheap and robust.

The resistance of an indicator should be so high that readings will not be perceptibly altered by any

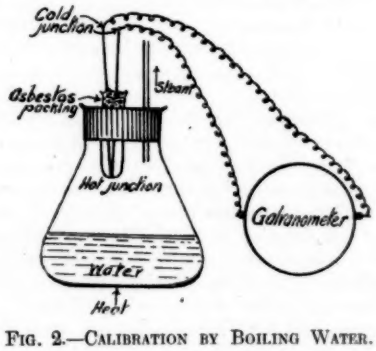


Fig. 2.—Calibration by Boiling Water.

fluctuations in the resistance of a circuit which may arise in practice. As most indicators of the robust portable type in works use are of low resistance, a good plan to combat the gradual increase in resistance in the leads is to break the wiring circuit with a fuse box, from which sufficient resistance can be taken to correct the resistance of the circuit. Actually, of course, this is

not a fuse-box proper, but the familiar fuse-box has been found to be extremely convenient for this purpose.

Calibration.—The construction of couples, as well as the method of their calibration, depends largely upon the purpose for which they are wanted. For example, a couple is frequently wanted to measure the temperature of superheated steam, and the essentials in this case are that the couple should give a good e.m.f. at low temperatures, and that the calibration must be accurate over the lower temperatures. The first point fixed is that of boiling water (100° C.), and if extreme accuracy is essential, then an allowance must be made for variations of atmospheric pressure. A good couple for low temperature indication is one composed of copper and constantan, the latter being an alloy of 60 per cent. copper and 40 per cent. nickel. The wires are carefully soldered together with silver solder. This process takes some little practice before it can be satisfactorily carried out, but if the wires are carefully cleaned and borax used

Fig. 3.—Works Pyrometer, Concentric Pattern.

as a flux, then the correct method is soon learned. The hot junction should appear like fig. 1 (*a*), and not like fig. 1 (*b*), and, of course, the wires must be insulated from each other before calibration is possible. Small clay marbles with holes in them are easily and cheaply made, and are quite satisfactory for this purpose. Fig. 1 (*c*). To accurately fix the boiling-water temperature, the couple should not be suspended in the actual water, but should be kept dry in a glass sheath, as shown in fig. 2. For temperatures below 100° C. another point can be fixed, namely, that of the boiling point of absolute alcohol, 79° C., but this is rarely done, and the best method is to calibrate with an accurate mercury thermometer. The thermometer can be employed for calibration purposes up to a temperature of some 200° C., and occasionally a check figure can be taken at the temperature of boiling aniline, *i.e.*, 184° C. If the temperatures which the couple will be called upon to estimate do not exceed about 300° C., then only two other points must be fixed. These are the freezing points of pure tin, 232° C., and pure lead, 327° C. Obviously the couple must be protected from these molten metals, and this is accomplished by enclosing it in a sheath preferably made from silica, which is a very refractory material. The metal is heated to slightly above its melting point when the couple is placed in it, and the pointer of the galvanometer is carefully watched. The pointer slowly

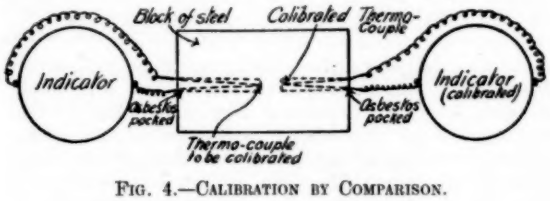


Fig. 4.—Calibration by Comparison.

falls until it becomes perfectly stationary for a few seconds, which is the point to be noted. When these points are plotted, a curve is obtained from which the galvanometer reading, which corresponds to any desired temperature below 300° C., can be found at a glance. It is important to note that the cold junction should be kept at a constant temperature both throughout the calibration and whenever the couple is in use. The zero position is also fixed with the cold junction at this constant temperature, which is generally the normal temperature of the room in which the calibration is carried out.

Pyrometers for the measurement of high temperatures are calibrated in much the same way, and the points taken are those of the freezing points of pure zinc (419° C.), aluminium (658° C.), silver (961° C.), and copper (1,085° C.). These metals must be quite pure, because small quantities of impurities effect their freezing points enormously. They must also be kept free from oxidising and sulphurous gases when melting, and so an electric furnace is preferable for this purpose, and a covering of lump charcoal will prevent undue oxidation, though aluminium must not be protected with charcoal, and it is advisable to renew the metal frequently.

Various couples are recommended for high-temperature pyrometers, and possibly the best one is a platinum—platinum, rhodium. These metals are, however, much too expensive for works purposes, and they are usually only employed in the laboratory, but they are useful for carrying out periodic check tests on base metal couples. A fairly common couple for works practice is composed of a nickel wire and a nickel-chromium wire, and there are many other patented wires of varying composition. Possibly the best type of pyrometer for works purposes is one in which the sheath takes the place of a wire, and the construction of such an instrument is shown in fig. 3. This type has several advantages which are not possessed by those which utilise two wires. In the first place, it is much more easy to insulate one wire than two; and, furthermore, these instruments are very robust and will withstand a comparatively large amount of rough usage. It is, however, not very convenient to calibrate this type of pyrometer rod by the freezing metals method, but an excellent substitute is to utilise a large block of steel with two holes drilled in it. In one hole is placed an accurately-calibrated couple, and in the other hole is the rod to be calibrated. The block of steel is slowly heated, and the two readings are thus compared at intervals, which method gives accurate results (fig. 4). The sheath is usually ordinary mild steel or wrought-

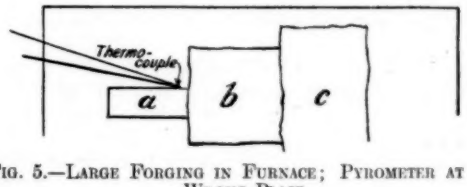


Fig. 5.—Large Forging in Furnace; Pyrometer at the Wrong Place.

iron tubing, whilst the wire is often a constantan wire insulated by means of hollow clay cylinders. The welding of the wire to the sheath is often a troublesome operation, but the writer has found that electric welding is fairly easily carried out, whilst oxy-acetylene welding and the like is extremely difficult. This class of thermo-couple is best fitted up with a special head, in which is wrapped a few turns of resistance wire, and so the e.m.f. which passes through the galvanometer can be quickly adjusted by merely altering the length of this wire.

Such couples as the foregoing give very satisfactory results for temperatures up to some 900° C., which is as high as is necessary for the majority of works purposes, and temperatures above this should be estimated with the aforementioned rare-metal couple. These couples, although giving better service than base-metal couples, are not infallible, because the rare metals become slightly affected by the gases which are usually found in furnaces, and, moreover, although the couples themselves will give good results with temperatures up to some 1,400° C., it is difficult to obtain satisfactory protective sheaths, as they are generally not sufficiently refractory or are much too brittle for works purposes. Should the wires become affected, they can often be made normal again by passing an electric current through them until they are red hot. To insulate such couples, perforated mica disks or silica tubes are satisfactory, but asbestos cord should not be employed unless it is known to be pure, because the commercial varieties often contain such deleterious substances as zinc oxide.

Protection of Couples.—The life of a thermo-couple depends largely upon the devices which are employed to protect it from the ravages of heat and oxidation.

For low temperatures it is a comparatively simple matter to do this, but for the estimation of "red" heats the problem is a difficult one. The filling of the protective tube, which contains the couple, with powdered sand or magnesia is advantageous, whilst an outer sheath made from a nickel-chrome alloy will resist the action of heat for a very long time, but such alloys are expensive at present. In measuring the casting temperatures of molten metals, as carried out in brass foundries, much damage is done to a couple, but further protective coatings of lime, graphite, alundum, fireclay, and so forth, assist in preventing excessively rapid damage. Thick graphite sheaths are sometimes used for this purpose, but they suffer from the marked disadvantage of causing a lag in the temperature reading, and for metals this cannot be allowed.

Conclusion.—The successful manipulation of pyrometers is largely a matter of common sense and attention to detail, the pyrometers are oftei blamed for failures when something else was really to blame. It is as well to remember that the pyrometer merely indicates the temperature of one small point, and so, if a lengthy article needs to be heated to a uniform temperature, then several rods must be employed. Fig. 5 shows a large forging in the furnace with a pyrometer at a; the small section of the shaft at a will be at the required temperature long before the larger parts b and c, therefore two other pyrometers should be used, one at b and one at c. This is a case in which a pyrometer may be blamed for an error which is really due to wrong placing of the thermo-couples. Finally, if all thermo-couples are periodically tested with an accurate couple, it will be found that excellent results will be obtained at a minimum cost.

SECRET COMMISSIONS AND CORRUPTION.

By THEODORE RICH.

THERE are certain practices which have been recognised for many years as being dangerous to society and with which the law in many countries has endeavoured to cope. Among these practices are the various forms of bribery and corruption which affect public, civic, and commercial life. The evil is to be found in many forms, from the handing over of cash in untraceable treasury notes to what might be termed mutual back-scratching; from cases where definite injury can be traced, to those where little harm has resulted to third parties.

Conspiracies of all kinds are very difficult to prove. The giving of secret commission is in a way a conspiracy between two parties to obtain mutual benefits at the direct or indirect expense or injury of a third party, who is connected to one of the former by the relationship of agency, master and servant, or some other connection involving duty with implicit trust and confidence.

The Progress of the Day.

Although it is customary for sociologists to declaim with fervour about the educational and other progress of the day, yet they rarely dwell upon the point that real progress should be accompanied by an improvement in business probity, whereas, if anything, the reverse is taking place. The steady permeation of our commerce by men of alien extraction and instincts, the multiplication of elective bodies and the increasing influence of adventurous men of straw, have led to a distinct lowering of the standard of business honesty of which the Britisher used to be justly proud.

At a time when the best men of the nation were putting on khaki or concentrating their efforts on works of national importance, many sharpers and friendly agents of wire-pulling groups wriggled into business, social, or administrative positions, for which, from the point of view of business trust they were utterly unfit. The confusion of war always seems to favour those blessed with modern "business acumen."

Men returning from Latin Republics to help the old country during the war were heard to say that in this golden age of international finance and professional politics we were rapidly losing our reputation for a "square deal." Many people who bitterly complained of what was going on dared not bring matters to a head for fear of being boycotted by those in key positions, who were lining their pockets while posing as patriots.

A Bribery Prevention League.

Lord Lambourne, of the Bribery and Secret Commissions Prevention League (of 9, Queen Street Place, E.C.4), at the annual meeting of the Society in May last, said that "Bribery is at present on the increase," and that people complain that "unless they turn a blind eye to these practices it is becoming increasingly difficult to secure business." The following is an extract from his speech:—

> The more obvious forms of bribery—cash down—may be conceivably less to the fore, though it is doubtful; but presents to wives, loans being made without repayment being asked for, purchases allowed and no account presented, services gratuitously rendered, which in the ordinary course of business would be charged for—all these mean underhand dodges for escaping from the arm of the law, are more common, I am afraid, that they should be.
>
> It must be remembered that bribes are given sometimes in self-protection so that work in hand or done may not be hindered or spoiled. Only the other day a decorator stated that unless he gave bribes his workmen's brushes were spoiled. This was a form not only of sabotage, but worse—blackmail.

A Difficult Problem.

In cases of secret commission one party gives the commission in cash, kind, or indirect benefits, the other party agreeing to accept it, a great difficulty being that the degree of wrong is often much greater on one side than on the other.

At present when so many factories are half empty, and employers are straining every nerve to keep their businesses together, it is often a difficult problem for the directors of an honourably-conducted concern to know what to do, if an offer is given of badly-wanted business, subject to some backstairs commission.

If in the interest of honest trade an effort is made to expose the corruption, then, owing to the sort of freemasonry that exists among rogues and wirepullers, the firm may later experience a sort of organised boycott from other directions, especially as the underground tentacles of undesirable finance are so omnipresent nowadays. If a firm refuses business because it is not prepared to pay the bribe, then in these cosmopolitan days such a firm is more likely to be jeered at than supported.

On the other hand, there are firms in the United Kingdom which have been notorious for their corrupt methods of obtaining business and of buying up, injuring, or squashing the trade of competitors. The practices are no secret, but such people have rarely, if ever, been prosecuted; the difficulties of getting legal proof are very great, and powerful influences can be brought tending to protect the wrongdoer.

Criminal Prosecutions.

According to the old common law, any person who holds judicial or other public office and who accepts payment or gifts to influence his conduct regarding business affairs connected with his duties, is guilty of bribery punishable by fine or imprisonment.

As the common law was not strong enough to deal with the evil, various Acts of Parliament have been passed. One is the Public Bodies Corrupt Practices Act, 1889, the offender being liable to a sentence of two years' imprisonment or a fine of £500.

In 1906 the Prevention of Corruption Act was passed. This Act deals with any agent or servant on the one hand, in any walk of life who accepts or obtains, or attempts to obtain, any gift or consideration as an inducement or reward for doing or forbearing to do any act in relation to his principal's affairs or business. It also deals with the person who gives, or offers to give, the benefits in question, a further clause dealing with the presentation of false or deceptive documents. The punishment which may be awarded is very similar to those under the 1889 Act. The permission of the Attorney-General has to be obtained, before proceedings can be started under this Act. This permission has at times been refused.

For all practical purposes this Act has remained a dead letter. The practical difficulties of setting the law in motion and getting sufficient evidence to secure conviction, has repeatedly given rise to complications, especially as pressure has been brought on witnesses to prevent exposure. The Bribery and Corruption League knows of hundreds of cases, but in the present state of society little can be done in the way of an effective prosecution.

Civil Actions.

Although it is difficult to put any material check to the evil through the criminal courts, yet from time to time the question is touched upon in civil cases. The common law has always tried to protect people who have been unduly influenced or imposed upon by those they have trusted, and it has tried to render void transactions which have been tinged with corruption.

Where an agent receives a secret profit from a third person with whom the agent is dealing on behalf of a principal, it is a breach of duty. It does not matter in such circumstances whether or not the bribe actually influences the agent in a manner detrimental to his principal. In cases, however, where the principal allows his agent to look to a third party for his remuneration or if the principal knows that something will be given, then the agent is entitled to receive and keep anything which is given. On the discovery that a bribe, such as a secret commission, has been accepted, the principal may instantly dismiss the agent, the commission of the latter, by way of recognised remuneration, is forfeited, and the agent becomes liable to the principal to the amount of the bribe, and he is also liable for any loss the law would recognise as being connected with the transaction.

Repudiation or Rescission of the Contract.

The question goes further than a matter of what is usually termed bribery, as, if a servant or agent enters into a transaction with a third party with whom the principal in dealing in such a way as to place himself in an anomalous position, it does not matter whether the principal might have objected or not, or whether the matter might have come to light by proper inquiry on the part of the principal; all the same, the state of affairs must be disclosed, otherwise there is danger that the court may rescind the contract concerned in the original deal.

In a leading case on this subject in 1875, Lord Justice Sir William James said: "Any surreptitious dealing between one principal and the agent of the other principal is a fraud on such other principal." He further said: "If a principal is conspiring with the servant of the other principal to cheat his master in the execution of a contract, then in common sense, common justice, and in this court the master is entitled to say: 'I will have nothing more to do with the business.'" In the case in question a consultant had very close relations with a contractor.

The Sale of a Motor-car.

A material proportion of the few cases which reach the courts, in which secret commissions are involved, are in connection with domestic and personal servants. It is interesting to remember that one reason for the rapid development of the multiple-department store forty years ago was the refusal of such establishments to pay commission to domestics on food, coal, forage, and other commodities. A case (Alexander and Another *v.* Webber) was heard a year ago, which illustrates the law.

A gentleman, since deceased, wanted a motor-car; his chauffeur told a coachbuilder of the name of Bath about it, Bath informing Webber, the defendant. The latter saw an advertisement of a car for sale, and he obtained an offer of it for £1,900; Bath offered the car to the master of the chauffeur at £2,250, reserving a quarter of the margin of profit to the chauffeur by arrangement, the master not being told about the matter.

The master, Mr. Alexander, paid a deposit of £250, and while remaining in ignorance of the secret commission, refused to complete the transaction; he then died. The executors got to know the truth, refused to pay the balance, and sued for the deposit. It was suggested for the defence that it was a custom of the trade to give commission to chauffeurs; the custom was, however, not accepted by the court. Owing to the existence of the secret commission judgment was given for the return of the deposit.

A Danger to the Community.

There are few practices more difficult to deal with and more injurious to the trade and to the welfare of the whole community than those regarding secret commissions. Hotbeds of corruption came into being during the war, and men who then grew powerful on their ill-gotten gains are now in responsible positions.

The popular policy in national and private affairs is to shake hands with anyone, provided there are prospects of business.

British business is gradually becoming saturated with a system of Asiatic "backsheesh"; all honour to those business men who do what they can, often at the expense and risk of their pockets, to stem the rising tide, however much they may be sneered at by their competitors. Business houses of the like of the "Brothers Cheeryble" are still to be found, although the wire-pulling adventurer and trust organiser is too often a subject of admiration.

Modern Tendencies.

At the present moment profits, if any, are cut very finely, and, apart from any other aspects, these are hardly the times when our trade can stand a continuous drain in the way of secret commissions on a material proportion of the business turnover. Men who are ultra-ingenious and smart too often begin to use their slimness in the interests of their own pockets to the detriment of their employers, and some people are beginning to think that in public and private affairs old-fashioned steady men are the best investment. A farmer who put doubtful stock into his herds would be laughed at, but in the same way a man who does not want to be humbugged, should think twice before he puts in positions of trust men with ultra-business acumen who do not come from the soundest British stock, otherwise he may have to pay dearly for his experience.

A strengthening of the law could do some good, but public opinion, without which the law is powerless, could do much more. Those at the top who have soiled their fingers with corruption cannot take steps to deal with the same sort of thing lower down. Without the world-wide goodwill of a reputation for straightforward dealing, a great deal of our trade would disappear, and now that the war period is over it is time that something was done to set our business house in order. There are far too many intermediaries in trade without the addition of secret commission cadgers.

EAST MIDLANDS ELECTRICITY SCHEME.

ELECTRICITY COMMISSIONERS' INQUIRY.

Many public authorities were represented at the inquiry which was opened at the Guildhall, Nottingham, on the 23rd ult., by the Electricity Commissioners, under the chairmanship of Sir John Snell, regarding a scheme which is proposed jointly by various municipal bodies for the supply of electricity within the East Midlands district, covering an area of 1,000 square miles, with Derby, Leicester and Nottingham as its principal centres, the other members of the Commission present, in addition to Sir John Snell, being Sir Harry Haward, Mr. H. Booth, and Mr. A. Page.

The Chairman, at the opening of the proceedings, referred to the circumstance that a new scheme had been submitted in place of that which was originally propounded. The inquiry was to have been held on July 11th of last year, and the necessary arrangements were completed for that purpose. The Commissioners were, however, then informed that the power undertakers were in negotiation and had arrived at a large measure of agreement. The Commissioners were, therefore, urged to postpone the inquiry in order that the negotiations might be completed, the result being that an amended scheme had now been brought forward with the suggestion that an advisory committee should be formed.

Mr. Tyldesley Jones (who with Mr. Sidney Turner appeared for the East Midland authorities) in detailing the various proposals which had emanated from East Midland conferences with regard to the matter during the last three or four years, explained that Messrs. Rider and Wordingham, who were originally instructed to prepare a scheme, presented their plans in August, 1919. The district which they then recommended as the area of supply was rather larger than that now under consideration and, with Chesterfield, comprised 2,000 square miles. They recommended that one large station should be built at Long Eaton, which was the centre of the area, with an ultimate capacity of 250,000 kW, the vital point in selecting that site being in relation to water requirements. At Long Eaton the suggested site was contiguous to the Trent, where there was the same quantity of water as at Nottingham, the Trent presenting the best condensing facilities in the district. It was pointed out by the engineers that if a second station was necessary the site was obviously Nottingham, which was sufficiently far from Long Eaton to receive the requisite quantity of water unimpaired. The idea of vesting all the generating stations in one authority in a district, disappeared as a compulsory matter from the Act of 1919. The Corporations of Derby, Leicester and Nottingham found that demands for electricity in their districts were so urgent that they could not delay in providing plant even for such a period as would be required for setting up a big station at Long Eaton. The matter was again referred to Messrs. Rider and Wordingham to make another report, which they presented in March, 1920, their main recommendation then being that instead of there being one new generating station there should be three chief sources of supply, with stations at Derby, Leicester and Nottingham. The engineers advised that the Derby station should be extended to a capacity of 40,000 kW, having regard to the condensing facilities of the Derwent; that a new station, constructed at Leicester, should be ultimately extended to provide 50,000 kW, the site being on the River Soar; and in the case of Nottingham they recommended that the ultimate capacity should be 250,000 kW, having regard to the greater resources of the Trent at that point for condensing purposes. To meet immediate demands they recommended that at certain other existing stations at Burton-on-Trent, Long Eaton, Loughborough, and Mansfield, small extensions should be made, but that when energy could be conveyed to the districts from central points those stations should be closed, and that each of the three big stations should supply the current, not only in the present area of supply of each Corporation, but in a larger district. Ultimately the three stations should be linked, and by these means a demand for 300,000 kW could be met. The engineers recommended that a Joint Electricity Authority should be formed, including all the authorised electricity undertakers. Their report was approved by a Conference of East Midland authorities, but the needs of Nottingham demanded that immediate independent action should be taken, for which purpose the Corporation had acquired power to erect a new station, according to plans prepared by Messrs. Rider & Wordingham, the idea being that this station, which was on a site contiguous to the Trent, and which was to be connected with the Midland Railway, should fit in with any ultimate scheme for the whole district. The Nottingham site had all the facilities as regarded land and water for a station of 250,000 kW. Substantial progress had already been made with the works, a capacity of 30,000 kW being arranged for at the outset. It was recommended that there should be an extension of the existing station at Burton-on-Trent, and there was a possibility of a new station being erected at Newark, where there was a very favourable site on the Trent for a station of ultimately 200,000 kW, as the development of the eastern part of the district might necessitate. The scheme provided that the Loughborough, Mansfield, Long Eaton, and Ilkeston stations should be closed as soon as a bulk supply could be made available for the areas affected. The scheme now proposed as to authority was analogous to the one accepted under somewhat similar circumstances in South-East Lancashire. So far as the administrative part went it was an agreed scheme, with the exception of a few minor details. He very much regretted, however, that there was not agreement regarding the technical part of the scheme, there being a difference of opinion between the power companies and the corporations as to the mode of providing energy most economically. For the generation of electricity the standard system proposed was three-phase at 50 cycles per second. The standard pressure should be, for the main transmission, 35,000 volts; and for the secondary transmission 11,000 and 6,000 volts, as at present. They were unanimous that the Spondon station should be utilised up to the limit of 40,000 kW, the deciding factor being the water supply available from the Derwent. The scheme proposed an Advisory Committee of not more than 27 members.

Ald. E. Huntsman, a leading member of the Nottingham Corporation and chairman of the Conference of East Midland Authorities, gave evidence in support of the scheme.

Mr. Craig Henderson, on behalf of the Derbyshire and Notts. Electrical Power Co., cross-examined Ald. Huntsman in relation to some of the financial details.

Replying to Sir Harry Haward, the witness said that the Nottingham station would be finished sometime next year and then the existing stations in the city would be closed. He considered that the North Wilford station ought to be the predominant station for the northern part of the area.

Mr. C. H. Wordingham, of the firm of Messrs. Rider and Wordingham, said that the acquisition of Spondon had introduced another efficient generating station and necessitated a modification of the scheme. Spondon was a modern economical station which ought to be used in the district. The only question was the distribution of the loads.

The inquiry was then adjourned. On the following day, Mr. Wordingham, continuing his evidence, said that the capacity at Spondon would be 40,000 kW. Whether there would be a generating station at Newark appeared at present uncertain, his view, however, being that there should be one, as the condensing facilities there were even better than at Nottingham; cheap coal was obtainable, as well as a good site. He had considered the question of an overhead transmission line from Nottingham to Newark, and there was a very substantial difference in favour of generating at Newark. He regarded the conditions at Newark as being almost ideal upon the score of economical generating. The distance from Nottingham to Newark was 21 miles.

In preparing the scheme two stages were observed, the first extending to the year 1926, and the second to 1931, but these were not intended to be taken as hard and fast periods. He proposed in the first stage that Derby and Burton-on-Trent should be linked together and a line should be run to the north-east to supply the Ripley area, Nottingham would be connected with Mansfield, Ilkeston, and Long Eaton, and a main would be run from Leicester to supply the Coalville district. According to his plans, Leicester was the most desirable station to carry the load of the southern part of the district, Derby, Spondon and Burton being in the western part and Nottingham in the centre and north-east part. The largest station would be at Nottingham, and the cost of production there should, he thought, be less than at the others. Since the preparation of his original statement he had lowered his figures on capital expenditure by 25 per cent., consequent upon the fall in prices. His first figures were computed on the basis of six per cent. interest on capital, but now they were put at four per cent., the sinking fund being taken on a three per cent. basis.

In the course of further examination by Mr. Tyldesley Jones, Mr. Wordingham explained that the total estimated capital expenditure was placed at £3,357,000, the total annual charges involved being calculated at £264,511.

In reply to questions by Mr. Craig Henderson, on behalf of the Derbyshire & Notts. Power Co., witness explained that one of the reasons why he suggested that Ilkeston should be supplied from Nottingham was because it was rather nearer to Nottingham than Spondon. He knew that Ilkeston was the supply area of the Derbyshire & Notts. Co., but that did not matter so far as the generating work was concerned. The Power Co. would benefit by buying its energy in the cheapest market. He would take it from counsel as being a fact that from the beginning of the following week, or thereabouts, Ilkeston would be getting its supply from Spondon. He had said that if Spondon were used to its full capacity, it might render Derby extensions undesirable, but it would not make the Nottingham extensions unnecessary. He did not agree with a suggestion that the Spondon station was capable of expansion to 70,000 or 80,000 kW.

The witness was subject to exhaustive cross-examination regarding the technical details of the scheme, which was continued on Thursday, when he stated that the total annual charges at the end of the first stage of development would be £718,000 as against £847,000 under individual extensions.

The Chairman directed attention to the fact that the Power Co.'s proposals provided for a total output of 397½ million kWh, whereas the East Midlands scheme provided for 323.8 million kWh.

Mr. Wordingham explained that the East Midlands calculations were based upon an estimated capital expenditure which was taken uniformly at £25 per kilowatt for stations employing sets less than 10,000 kW in size and £22 10s. for stations above. Necessarily an amendment of the transmission costs would be involved by the bringing-in of Spondon. He agreed with the chairman's suggestion that the whole question resolved itself into what would be the cost of generation at Spondon and Nottingham.

The Chairman: The essential difference between the two sets of proposals before the Commissioners is that in the conference case you take an easterly line which runs directly from Mansfield to Nottingham and thence to Loughborough and Leicester, whereas the Power Co.'s line runs directly from Spondon to Hinckley. If, after careful examination by the Commissioners, it was found that a modification of the conference line would result in better economy while at the same time enveloping the same districts of supply, would you be prepared to advise your clients to agree to that amendment?

Mr. Wordingham: That which I should want to be satisfied about would be that the combination of the generating stations and the respective costs at those stations with the transmission lines would result in delivering the cheapest energy at the respective strategic points. In other words, the generating costs cannot be taken by themselves, nor can the transmission lines be considered alone. They must be taken in conjunction. The crux of the whole matter is the cost of the delivered energy.

The Chairman suggested that by harmonious working with the Power Co., a transmission system might be evolved under the general direction of the Advisory Committee which would represent the lowest capital outlay on a transmission system, compared with a possible duplication of transmission if they were not working harmoniously.

Mr. T. P. Wilmshurst, electrical engineer to the Derby Corporation, who was the next witness, said that the facilities for generating electricity at Derby were much superior to those at Spondon. In summer the depth of the river at Spondon was only 18 inches.

Mr. McMillan, Professor of Mining at Nottingham University College, gave evidence as to the existence of valuable coalfields to the East of Nottingham, stating that coal had been proved practically up to Newark and new pits would shortly be opened.

Mr. J. A. Rider, consulting electrical engineer to the Nottingham Corporation, stated that the Nottingham station had been so designed as to be a perfectly economical station for Nottingham, whilst it could be developed into a very large station to serve the purposes of the general area. The building now in course of construction would take two 10,000- and one 20,000-kW sets. Land would be purchased and the whole of the contracts let, except certain building contracts. Taking the actual contract figures, including engineering charges and making proper estimates for contracts not already let, the total cost of the 30,000-kilowatt station, including land for 250,000 kW, if desired, and railway sidings, would be £733,000. If the station were extended, as he proposed, first by one 20,000-kW set and then by another, the cost per kilowatt for the whole station would be, for 50,000 kW installed, £20 per kilowatt and for 70,000 kW installed £20.3. The maximum demand for electricity in Nottingham in March, 1922, was 10,110 kW and 17½ million kWh was sold. That was before the Corporation had two turbines working in the new temporary station. Because of the cheaper rate he believed the demand would go up at a far greater rate than in the past. As to the facilities afforded by the Trent, the absolute minimum was 8.4 million gallons per hour. In contrast with the existing stations in the city, the saving would be "beyond the dreams of avarice."

In the course of discussion, surprise was expressed by the Commissioners that the Nottingham Corporation had outstanding loans with nearly 30 years to run for obsolete plant.

The Chairman indicated the intention of the Commissioners to impose a terminal period for the repayment of these old loans.

Mr. W. B. Woodhouse, engineer to the Yorkshire Power Co., said that the Derbyshire & Notts. Power Co.'s organisation must be used unless there was to be duplication of mains and heavy unnecessary expense. If power companies were excluded from these densely populated districts and if municipalities were to be allowed to go there, it would be difficult for power companies to carry on. It was essential, however, that there should be co-operation. The cost of the Spondon station was £375,000, and by an outlay of £85,000 the present installed capacity of 12,000 kW could be doubled. A total capacity of installed plant up to 36,000 kW would bring the cost up to £640,000 equivalent to £18 per kW.

In reply to Mr. Tyldesley Jones, Mr. Woodhouse agreed that the company was under a legal obligation to give a supply to a colliery in the neighbourhood of Mansfield, subject to a certain gross return on the expenditure. The company's prices were quite high—3d. per kWh for the first 400 hours and 2d. afterwards. The obligation was subject to a condition as to supplying on equally favourable terms to other companies within that part of the area. He admitted that no supply was given to-day by the Power Co. in the Mansfield district, so that there was no other consumer with whom a comparison could be made. To supply a colliery, say in the Birmingham area, on the most economical terms, he suggested friendly co-operation between the Nottingham Corporation and the company. If Loughborough wanted a supply from Leicester, no main could be laid unless the Power Co. was willing to lay it or for someone else to lay it. The Commissioners had powers in the public interest to deal, under the 1919 Act, with any merely obstructive tactics by a company, if the Advisory Committee was unable to secure a friendly agreement. He agreed that if the company would not lay the main referred to from Loughborough to Leicester somebody else should be able to do so and that was not in the scheme. If the company knew that it was protected within its distributing area it could deal with such a request.

Mr. Woodhouse directed the attention of the Commissioners to the fact that any special circumstances regarding alteration of a municipality's boundaries could be dealt with by agreement as had been done at Derby. He understood that the Derbyshire and Notts. Co. was ready to spend the money required for its scheme.

The Chairman asked whether it would be practicable for an agreement to be made between the power companies and the local authorities by which either could supply to the other energy in bulk on prescribed terms.

Mr. Woodhouse replied that he thought it would not only be practicable but most desirable. The different undertakings were so closely in agreement that, if they could only clear up the uncertainty of overlapping there would be no obstacle in the way of concluding an agreement at once. Subject to a satisfactory settlement of the technical scheme, the companies were prepared to join the committee, although there would be only five company representatives on it. He thought that indicated goodwill on the part of the company and a desire to co-operate. What they were concerned about was the security of their position.

Mr. Hugh L. Williams, a director of the Derbyshire and Notts. Power Co., who gave evidence also for the Leicester and Warwick Co., which possesses collateral interests, stated that the first-named put the Spondon station into commission last Christmas. Giving details of the extensions now being effected, he explained that the proposal of the companies was to link up the two supplies. The company having got into its new station was very anxious to develop the area and was on the way to Mansfield. It had got as far as Heanor and another line was in contemplation from Heanor to Mansfield. Negotiations were in progress with colliery proprietors for the supply of energy in the Mansfield district, especially to the Butterley Company.

The inquiry was concluded on Friday, when addressing the Commissioners on behalf of the London, Midland & Scottish Railway, Mr. A. Tylor declared that they were anxious to co-operate in formulating an efficient scheme. In respect of the district from the point of view of future electrification the line from Nottingham to Derby, with regard to passenger traffic, certainly presented possibilities, but in the case of freight electrification there were no gradients which would make the district one pre-eminently suitable for electrification, except in the vicinity of Mansfield and Ambergate. Mr. Tylor afterwards dealt with objections which the company entertained to certain clauses in the scheme.

Mr. H. L. Williams was recalled for further examination by Mr. Tyldesley Jones, who asked him whether, if Nottingham had powers to supply Mansfield with current and laid cables through the Power Co.'s area, the company would object.

Mr. Williams replied that it certainly would.

In answer to Mr. Henderson, witness explained that the £375,000 capital cost of the Spondon station had been taken up by the holding company in shares of the Derbyshire and Notts. Power Co. It would necessarily reduce the chance of getting any further capital if the area of the company was cut down in the way which had been suggested. The Leicestershire & Warwickshire Power Co. intended making application for a special order for distribution for Coalville and the application would be supported by the Coalville Urban District Council. The Derbyshire & Notts. Power Co. would lay and maintain the main up to its boundary and the other company would do so beyond it.

Mr. Ellis, on behalf of the Southwell Rural District Council, asked for representation on the Advisory Committee.

Mr. Craig Henderson, in addressing the Commissioners on behalf of the Derbyshire & Notts. Power Co., said he had hoped to come as a supporter, but had been forced into the position of an opponent. It appeared that the scheme which had been put forward with his client's consent, was to have tacked on to it, at the instance of the municipalities, an underlying principle of supply by the municipalities of their "surrounds," and of the area covered by linking as part

of the scheme. He had hoped that the object of the Advisory Committee would be to discuss the organisation of the area, but instead of that they were faced with a cut and dried scheme, prepared with the assistance of Mr. Wordingham, who said that the only use of Spondon was to supplement Derby. The Derbyshire and Notts. Co. was working in collaboration with another company to the south for the development of the non-municipal area. They had to supply the power load and could supply lighting load as well. It was clear that Mr. Wordingham had firmly fixed in his mind that the scheme must be a municipal one and not an electricity scheme for the district. The company was to have representatives on the Advisory Committee, but they could only constitute a small minority, and he asked the Commissioners not to handcuff them. He contended that, by the scheme propounded by the municipalities, all security would be cut away from the power companies, for the only way in which to give security was to allow a company to develop its powers. The essence of the company's case was that it was too early yet to lay down the exact routes that mains should follow. If the municipalities were to be allowed to jump the company's claims there could be no co-operation. The company was compelled to fight for its existence. The station at Spondon had been designed for a much greater capacity than 40,000 kilowatts. The company went into the scheme on the basis that each party had its rights and duties and should assist each other. That principle, however, would be undermined by having tacked on to the administrative scheme a technical scheme of the Corporation's, and he asked the Commissioners to see in any draft order which might be made, that that was not permitted.

Mr. Tyldesley Jones, in the course of his reply on behalf of the East Midland Authorities, confessed that the inquiry had been a bitter disappointment to him, as he had hoped it would have had the effect of dissipating a suspicious atmosphere. It was admitted that the present arrangements as to electricity supply in the district were very unsatisfactory and no improvement would be effected by each party's insisting upon the exercise of its present statutory powers. There was this underlying difference between the two sides, that the Power Co. wanted it laid down that all transmission lines outside the municipal area should be laid and owned by the company. In no case that he had ever heard of had a company had the temerity to put such a claim before a Parliamentary Committee. If there was to be no intercommunication between Nottingham and Mansfield, for example, they would be under the same organisation as before. The demand of the Corporation was that electricity should be distributed from the stations where it could be most economically generated. The Nottingham Corporation was promoting a Bill in Parliament to extend its distributing area.

The Chairman: The best results can only be obtained by goodwill. An improvement is badly needed, and one of the essentials is that within a period of two years a scheme is to be submitted by an Advisory Committee to improve distribution. Is it likely to produce that good feeling if prior to the Advisory Committee having considered the best means of improving the supply, one of the most important of the Corporations, the one which owns the largest station in the district, stakes out a claim for a large part of the area, including two districts which are now being served by one of the constituent authorities in the scheme? Would it not be better to adopt the *status quo* until the Committee brings about the best scheme?

Mr. Jones: You have heard the extravagant claims of the company, and if we did not do the same thing nothing would be done. These districts are of the greatest importance to Nottingham.

The Chairman: You know perfectly well that the Commissioners have other powers. If the Power Co. misuses its powers, there are other means whereby the Commissioners can act.

Mr. Jones: That does not help us, however, to develop and occupy those areas.

The Chairman: Quite true, but we want the velvet glove and not the iron hand. We want goodwill.

Mr. Jones, after consulting with the representatives of municipal authorities, said that if the Power Co. was ready to talk to the Nottingham Corporation about the areas, without waiting for the scheme to become effective, the Corporation was quite prepared to discuss the matter.

The Chairman: That is as far as I can ask you to go.

The Chairman intimated that the Commissioners would visit the various stations in the district before concluding the inquiry. The formal proceedings then terminated.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Readers are invited to submit particulars of new or improved devices and apparatus, which will be published if considered of sufficient interest.

Sterling Broadcasting Receivers.

The Sterling Telephone & Electric Co., Ltd., 210-212, Tottenham Court Road, W.1, has published a catalogue of its radio-telephony reception equipment. The crystal set is similar to the majority of such receivers, but the variation of inductance is made on two rheostats for coarse and fine tuning. The two-valve equipment, illustrated in fig. 1, is of

Fig. 1.—The "Sterling" Two-Valve Radio Receiving Set.

substantial and compact construction. The valves are fully protected by being placed in the box itself; two inspection windows are provided at the top to enable the operator to see that they are functioning satisfactorily. Four telephone terminals are provided, and a step-down transformer in the instrument enables low-resistance telephones to be used. In addition there are two terminals for the connection of a loud speaker and a switch to effect a change-over from the telephones. There is also a pair of terminals for the connection of extra coils to enable large wave-lengths to be received. For "broadcasting" purposes the effective range is said to be about 50 miles.

A "Hart" Radio Battery.

The accompanying illustration (fig. 2) shows the "Hart" 6-volt "Meg. 9" battery, having capacity of 40 ampere-hours on continuous discharge, which is now greatly in demand as the filament battery for radio work. The battery consists of three cells in glass boxes with sealed ebonite lids and vent plugs, and is contained in a waxed wood crate with finger grips on ends, or a strap carrying handle, as preferred by purchasers. The leading wireless companies in the country are large users of these batteries, and have expressed their satisfaction. The batteries are made in portable form to give 4 or 6 V with from 20 to 60 ampere-hours' continuous capacity.

Fig. 2.—A "Hart" Radio Battery.

A Flexible Slack Absorber.

Messrs. J. H. Collie & Co., 8, Harrington Street, Liverpool, have sent us a sample of a simple little device for taking up the extra length which is necessary in flexibles connecting

appliances to plugs or lampholders. It consists merely of a spring, having a paper-clip at each end. The tension of the spring is such that it only retracts when the appliance is moved and it has an extension of about a yard, enabling the device to take up quite a large loop of flex.

The "Owl" Push Button.

We have received from Clear Hooters, Ltd., Highgate Square, Birmingham, a simply-constructed push button designed for automobile use. It consists of a base of insulating material with brass strip terminals and a spring copper contact. The screws for the leads have cupped washers which ensure a tight connection. The case is of polished aluminium, and the push button of a black hard-rubber material. The push is 1½ in. in diameter and 1½ in. in height.

CORRESPONDENCE.

Letters received by us **after 5 p.m. on Tuesday** *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Oil-ring Lubrication.

I have read with interest Mr. Towlson's interesting article on "Oil-ring Lubrication."

In order to overcome the difficulty which led to the adoption of chain oiling there are oil rings on the market divided across the diameter and fitted with a hinge and locking device somewhat after the style of a bracelet, so that they can be opened, slipped over the shaft, and closed up again.

I shall be pleased to give to anyone interested, particulars of one such ring.

O. L. Record.

London, *January 26th*, 1923.

A Motor-car Starter Problem.

I think the whole cause of "Wouldn't Charge's" trouble is in the seating of the brushes on the commutator.

I have had considerable experience with automobile starting and lighting sets, and have often found that a dynamo will function as a motor, but unless the brush seating be perfect the field will not build up in order that it may operate as a generator, especially in the case of dynamos with the third brush method of regulation. I am presuming that the dynamo in question has this method of regulation. Also a very small adjustment of the field brush will make a great difference to the maximum output.

When the dynamo gave 6 amperes on test, I should say that only the front edge of the brush was making contact on the commutator, and after fitting to the car the trailing edge made contact. It is quite possible that this rock of the brush would make the difference between 6 and 16 amperes, especially if the brush be a thick one, and the probable causes are: A bad seating, a weak spring, or a stiff brush lead.

On most American machines this field brush is made thin, usually ¼ in. or 3/16 in., so that the effects of bad seating are minimised.

Richard G. Fletcher.

London, *January 23rd*, 1923.

Change-over Experiences.

I am interested in the article in your current issue by Mr. H. Corner, entitled "Some Experiences of a Change-over." I have some knowledge of recent change-overs from d.c. to single-phase a.c., and agree with most of Mr. Corner's remarks.

With regard to the changing of motors, however, I would suggest that all trouble in this direction would have been avoided, if single-phase motors of the commutator type had been installed. This type of machine, from the consumer's point of view, is so like the d.c. motor it replaces, that he is much more likely to accept it without doubts as to whether he is getting the worst of the deal, than is the case if induction motors are installed. Further, all doubt is dispelled when he finds that the single-phase commutator motor starts up with or without load, just as easily as his d.c. motor did, and in fact operates in all respects as well as a d.c. machine (the only case where this motor does not quite equal the d.c. machine being where speed control over a wide range is required).

Further, if motors of the "phase compensated" type (Creedy Patent) are installed, the supply authority gains the benefit of a power load at high power-factor, and the consumer would also gain considerably, if at a later date, as is highly probable, he was charged for his supply on a kVA instead of a kilowatt basis.

In a recent change-over, where a considerable number of motors of this type were installed, ranging from 1 to 30 h.p., the power-factor on the whole system is very high, for the motors when running at full load operate at practically unity power-factor, and in some cases, individual motors, on fractional load, are giving a leading power-factor.

This particular change-over was carried out, so far as the actual change of meters and motors was concerned, in a remarkably short time, partly, no doubt, due to the fact that no motor troubles, such as described by Mr. Corner, were experienced, and the staff engaged on the change-over had not to waste any time in instructing the consumers how to start their new motors.

To sum up, the change-over from d.c. to single-phase can hardly be looked upon as a progressive step, unless commutator motors of some type or other are an essential part of the scheme.

To use split-phase induction motors is asking for trouble, and in view of their poor characteristics, it is surprising that when more modern and far better types of single-phase motors are available, these split-phase motors are still being installed.

Engineers in charge of change-over schemes should remember that from the consumer's point of view, they cannot improve on his d.c. motor, and if he should have this taken from him and exchanged for a single-phase motor, it is bad for electricity supply as a whole to give him a bad type of motor when there are good single-phase motors available. Certainly a bad substitute does not pay on a change-over job.

Referring to Mr. Corner's method of overcoming low speed on vacuum cleaners on a.c., by introducing a resistance in the field circuit, I cannot quite follow this; surely the trouble is due to too much resistance on a.c., *i.e.*, the ohmic plus the apparent resistance (self-induction).

The common forms of universally wound motors pass less current on a.c. than on d.c. of the same voltage, and being of the series type they therefore develop less power and run at lower speed. This can be corrected by reducing the resistance, say, by cutting out a few turns of the field coils, or the addition of a resistance in *parallel* with the field.

W. L. Wreford.

London, S.W.2,
January 23rd, 1923.

The Sale of Wireless Apparatus.

As a contractor with some knowledge of the telephone industry in all its stages, I find it difficult to follow your reasoning, which appears to be unduly biased in favour of unorthodox trading. The confusion existing is not due to any organised opposition on the part of the contracting community; on the other hand any hesitancy on their part is probably justified, and due to professional cautiousness necessitated by circumstances beyond their control.

Permit me to briefly review the situation in this area, and commence with the broadcasting station which has now been in operation for about 10 weeks or more; it is nightly described as the temporary broadcasting station! In the *Wireless World* of December 30th, 1922, the following reference appears: "Because of the experimental nature of the station, further technical details are not yet available for publication."

A speaker at the Rotary Club publicly stated that the professionals would do well to seek the aid of amateurs, and, technically speaking, this appears to hit the nail on the head in more senses than one.

The advertising medium appeals to the "discriminating amateur," also indicates that they are getting the best of it. In fact, one advertiser is good enough to announce that "Owing to the restrictions of the Postmaster-General, broadcasting reception has been made very inefficient for the public!"

As far as the public is concerned there may appear to be nothing to prevent the sale of the best that money can buy, and the matter of licence may also be the customer's funeral, but I venture to say that the established contractor would prefer that this class of business should not be traced back to him.

The use of head-gears every night with the best of programmes would represent a change in our domestic life that could not be anticipated.

The wireless business should not be treated as a scientific toy, but as a practical and indispensable appliance, and contractors are entitled to expect the wireless business to develop on ordinary telephone lines as existing:—

The trade to buy;
The trade to install;
The trade to maintain;

Instead, unhappily, the wireless was boomed in the lay Press before either the sets or the broadcasting stations were available.

As an example of the "Gilbertian" situation, our motor-car people sell "wireless" but they do not give us trade terms, and neither does the newspaper man, although one might possibly buy six or seven papers a week. How they must chuckle and wonder why the electrical manufacturer should devastate the electrical industry in their interests and break down those barriers so rigidly observed by themselves, which allows the newspaper man to post up a notice:—

"Wireless supplied to the trade and shippers."

Touching on the question of transmission and going back a bit, no doubt some will remember the pure quality of the

"Blake" transmitter, and the objection to the "nasal" tone of the granular carbon transmitters when first introduced! It was unsuitable for the transmission of music, and consequently to broadcast music *by wire* the "Ader" transmitter was employed, with great success. Later on, for reasons of space, another transmitter was once adopted for a short period with disastrous results, for it lacked faithfulness and purity of sound in reproduction, and in consequence all judges of music put down their receivers and rightly denounced it as a "soulless" performance. Bear in mind that the position of the artiste on the stage is not regulated to suit the transmitter, any more than the theatre is draped for similar reasons. This early experience proves that the "engineer's blessing" will not coerce the music-loving public, and one cannot help wondering why after so many years there should be any doubt about the choice of the transmitter.

We in the North are glad to hear that London people enjoyed the Covent Garden Opera by means of crystal sets! The owners of similar instruments up here were told that the local broadcasting station would close down for the purpose! Many are wondering why they could not participate in this rich feast. Is this the fault of the contractors?

In my opinion a frank and clear statement of policy would be quite as beneficial as the better co-operation between the manufacturer and the contractor.

A cordial and beneficial arrangement exists in nearly every other branch of the electrical industry, and why any dividing line should now take place in this particular branch, is a matter for regret and close investigation, at least before the contracting industry is saddled with the condemnation of such a highly-placed journal as the Electrical Review.

In an article on the same page you point out the wisdom of not "slanging one's opponents," and also that "even a so-called British public is able to discriminate." I venture respectfully to ask why this argument cannot obtain in the contractors' case also.

L. E. Wilson.

Manchester, *January 23rd*, 1923.

[Anxious as we are to grasp our correspondent's intention, we regret to say that after re-reading his letter we are unable to do so.—Eds. Elec. Rev.].

Lister Electric Lighting Sets.

We notice in your issue of January 19th, an advertisement by Messrs. Flather, of Leeds, in which they state that "the following engine makers fit and supply Flather dynamos," among the list being Messrs. Lister, Ltd., Dursley.

We fear that the wording of this advertisement, no doubt unintentionally, is likely to make people think that Messrs. Lister & Co. are now fitting and supplying Flather dynamos in place of ours, and is therefore calculated to do us considerable injury.

The facts are quite contrary to this, as we are still supplying dynamos for Messrs. Lister's electric lighting plants, as we have done for the past 15 to 16 years, and during this period we have supplied every machine which Messrs. Lister and Co. have fitted to their engines, with the exception of a few machines which at one time they had to purchase elsewhere, owing to our inability to give quick delivery due to pressure of work, and two or three cases in which other makes have been specified.

Messrs. Lister & Co., inform us that they cannot trace ever having coupled a Flather dynamo to their engine.

We shall be glad if you will publish this letter, as we fear the advertisement will give an entirely wrong and injurious impression to many of your readers.

Mawdsley's, Ltd.

Dursley, *January 26th*, 1923.

[Messrs. Flather & Co., Ltd., inform us that they had not the slightest intention of giving a wrong impression; a number of their dynamos have been purchased by customers who are driving them with Lister engines, but whether Messrs. Lister, Ltd., or the purchasers fitted them, Messrs. Flather do not know. However, Messrs. Lister's name will be omitted from the list in future.—Eds. Elec. Rev.]

Static Charge in Printing Machinery.

I note with keen interest the letter in your "Correspondence" Column re "Static Charge in Printing Machinery" by "Inquirer."

Whilst I was employed for a short period in a local newspaper works I took particular interest in a Quad. Hoe rotary, because many times I actually saw the sparking, due to the static charge in the paper, when it passed over a metal tension roller pipe.

Now, I would like to ask "Inquirer," or other readers, if it is a fact that this static charge does cause the paper to cling so much that it breaks. In my opinion, backed by close observation, it does not or cannot cause a stoppage, because (*a*) The static charge would be very evenly distributed, so causing an even pull along the whole surface of the paper; (*b*) it would need a very strong tension to break the paper, as will be known by the amount of brake that can be used when applied evenly on the machines. I, also, would be glad to read other opinions on this subject.

R. Bottger,
Electrical Engineer.

Hull, *January 28th*, 1923.

With reference to your correspondent's inquiry, I can give him the following two remedies. The former is used in cases that are not too bad, but the latter is a permanent cure.

(1) Damp the edges of the paper reels with water. Fix strips of paper on the delivery drum with paste, and smear with glycerine.

(2) The use of an apparatus that neutralises the static charge in the paper. This consists of a transformer stepping up to 10,000 volts, with high-pressure cable running to a "neutraliser" on the machine.

The makers are Messrs. Chapman Neutralizer Co., Portland Maine, U.S.A., or London agents, Messrs. Cross Feeder Co.

If "Inquirer" wishes to know any further particulars, or to see the above under working conditions, I should be pleased to give him more information.

F. R. Padbury.

Uxbridge, *January 27th*, 1923.

Student Engineers.

I wish to shake the hand of "Observer" for aptly showing up such a form of cheap labour. Most student engineers don't obtain diplomas at the age of 18, but have to attend night schools three nights a week for five years, and then would be about 22 years of age.

What is a man at this age, who would have to live in diggings, going to do with 30s. a week? Evidently the Newcastle Electric Supply Co. is expecting men who have had legacies left to them.

There are other firms who require mildly showing up; these firms have a system of periodically sacking every six months and then using your columns to advertise for labour, especially for draughtsmen.

Some of these firms I notice have been at it again recently, one of them being a hot-bed of Masons. I would advise men other than Masons to stick to their present jobs, no matter how fed up they are, if they wish to be in work in another six months' time.

January 24th, 1923. **'Ad Sum.**

I read with interest "Observer's" letter on the subject of "Student Engineers" for Newcastle in the Review of January 19th, and I think it very considerate of him to issue such a timely warning to the applicants for these posts.

It no doubt is quite true that the selected applicants supply the company with "cheap, yet efficient labour," but is there any company that, in its right senses, would be willing to furnish a number of young men with three years' good training plus a small salary and expect no return? On the other hand, the young engineer will learn far more by doing things himself, with the necessary guidance, than by watching others do the work.

As to the student's outlook at the expiration of the three years, all I can say is that if he has proved his worth and shown himself an upright and capable man, there is no reason why he should not be given a good position. Even if he is dismissed, he stands as good a chance of getting a post elsewhere as the next man, for it is well known that employers advertising for junior engineers select those with a college training and some experience in preference to those with college training only.

In conclusion, I hold that it is up to every successful applicant to "put his back into it" and show himself to the best advantage in the eyes of his employer. If this is carried out always, he ought to do well and rise high in the universal struggle for existence.

January 25th, 1923. **A Prospective Student Engineer.**

I have read with interest a letter by "Observer" under the heading "Student Engineers" in last week's issue, and the impressions which may be gathered are most misleading.

"Observer" refers to the pre-war arrangements made by the north-east coast power companies, to give young men an opportunity of obtaining experience in the operation of these large and "go-ahead" undertakings. I am sure the majority of men thoroughly appreciated the chance of handling such varied types of plant and apparatus, together with the study of a most extensive and complex system; my own experience in that capacity was a most happy one, and the benefit to me has been most marked in after years.

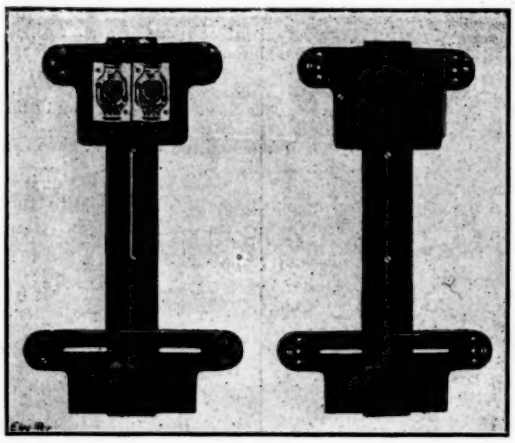
Surely it is unfair to attempt to discourage those men who are able and willing to take advantage of such a scheme. Any man of grit who undertakes the course of training has every chance of making good, and, fortunately for the industry, the percentage of "blackberries" is extremely small.

January 23rd, 1923. **An Old N.E.S. Co.**

The Theft of Electricity.

I have read with interest the short comment of Mr. A. Preston appearing under the above heading of your issue of January 19th, and I believe that many engineers endorse the same view on the necessity of a complete d.p. fuse unit and meter in one case.

Though such a meter does not yet exist, I think that it might interest your readers to hear of a patent device for the same purpose, which has been recently put on the market. It is the "Theco" patent board, which besides fulfilling the same object as the ordinary wooden meter board with fuses and insulators, protects also the wiring and connections.



The accompanying illustrations show the standard pattern. It is pressed out from iron sheet, and is sold complete with d.p. renewable fuses, protected with cover, with sealing arrangement and insulators fixed at the back of each of the four extremities.

When fixed in position, all connections, from the main fuses to the meter, and all wiring between them, are completely encased in iron, and cannot be reached without removing the cover of the meter terminal box.

The assembling is done on the interlocking principle without screw or pins, and takes far less time than the common wooden board. It allows any standard make of single-phase meter to be used. It is interesting to note that the design has been simplified, so that it is sold at a price lower than that of a similar wooden board.

Judging from the great success obtained on the Continent, where the "Theco" board is manufactured on a large scale, it seems that it appeals not only for the protection offered against tampering, risks of fire, &c., but also for a considerable reduction both in erection and initial costs.

I will be pleased to supply additional information to any of your readers.

O. E. Malinverno.

London, *January 24th*, 1923.

Consideration of this subject has so far been confined to cases in which the correct registration of the meter has been prevented. This necessitates tampering with the supply company's apparatus or wiring and requires some knowledge and considerable skill to avoid detection by an ordinarily observant meter reader or inspector.

A much more common method of theft is made possible, and even fostered, by the general practice of having different rates for energy used for lighting, heating, or power. The consumer can effect a considerable saving at the expense of the supply undertaking by connecting a large part of his lighting to the heating or power circuits. In the case of a three-phase power supply, metered by one or two meters, a single-phase supply can be obtained gratis from the unmetered phases or phase. Similarly, a free supply can often be obtained from one good outer and the neutral wire or a good earth connection of a 3-wire d.c. supply. The connections in these cases are on the consumer's wiring and the possibility of detection is remote.

I experienced an unusual (though on this occasion quite innocent) case in which power was obtained without its being metered. A 1-h.p. three-phase squirrel-cage motor was controlled by an ordinary three-pole knife switch. On releasing the pressure of the hand from the switch after starting the motor, the switch blades of the phase on which the meter happened to be, broke contact, and the meter stopped, but running on two phases at a reduced speed the motor provided all the power required by the consumer.

W. F. Sands.

Sowerby Bridge, *January 22nd*, 1923.

London's Electricity Supply.

The letter from Mr. Purse in last week's ELECTRICAL REVIEW is most interesting, and I entirely agree with his criticism of the proposed bulk supply for London. Perhaps an example showing how the cost of a bulk supply works out in practice will be more interesting still. I assume that the supply station charges the net cost price per unit, plus 5 per cent. profit. The two stations are in the London area and the figures are for the year 1921-22. We will call the supplying station "A" and the station receiving the supply "B." Station "B" generated about 5¼ million units at a total generating cost of £38,000. If the supply had been taken in bulk from "A" the cost for the same number of units would have been £48,900. Further, "B" would have had to expend about £25,000 on converting plant and switchgear, and £12,000 on mains, involving a further annual charge of about £3,460, which means that "B's" costs would have increased by no less than £14,360. The supply might have been abundant, but it certainly would not have been cheap. "B" is now taking a part bulk supply from "A," and the consumers are expecting a big reduction in price in consequence thereof.

W. R. Elliott.

London, *January 29th*, 1923.

Watt-hour Meters for Alternating-current Consumers.

The official definition of a unit of electricity for electricity supply purposes is a current of 1,000 amperes at a pressure of one volt for a period of one hour.

In continuous-current systems, where it does not matter much whether the consumer is charged by means of an ampere-hour or a watt-hour meter, the former is almost invariably used. In the case of alternating-current systems, where it does matter very much indeed, although the earliest meters were of the ampere-hour type, it is almost universal practice to use watt-hour meters.

Can anyone tell me the name of the genius who invented watt-hour meters for consumers on alternating-current systems and give me reasons why we should not revert to ampere-hour meters and make the consumer pay for the unit as defined in Orders and Acts, instead of supplying him with something a great deal more than the official unit, and at the same time spending huge sums of money in making the amperes he uses coincide with the amperes he pays for?

A. Hugh Seabrook.

London, *January 30th*, 1923.

Combined Water and Electricity Supply.—Mr. R. Cecil Creasey, electrical engineer, Albury (N.S.W.), writing recently in the *Commonwealth Engineer*, describes the advantages which have accrued from the combination of the water and electricity supply services in his town. He states that the use of electricity for purposes other than lighting is handicapped by the high rates for energy which are necessitated by the time a plant is not fully loaded, although running. It was found that when the demand for electricity by the town was at a minimum the quantity of water required was greatest, *i.e.*, in summer. As regards daily operation, the municipality is able to pump sufficient water during the period from 1 a.m. to 6 or 8 a.m. to last for the day in winter. In the spring and autumn slack periods come from 5 to 7 p.m., and the increased demand for water can be met during this period. In summer, pumping can be continued from midnight to 6 or 7 p.m., being cut out only for the lighting peak. The pumps can often be run right through the week-end. Where, as in Albury, the power and pumping stations are situated together, the town water can be pumped through surface condensers, which means that the electricity department is actually being paid for pumping its circulating water during much of the time it is operating. When the town supply pump is not in operation, water can be pumped for the condensers by means of an auxiliary pump and delivered to settling tanks or returned to the river. During the year 1921 the cost per kWh sold was 1.995d.; without the pumping load it would have been 2.45d. The charge to the water department was 2d. per kWh. The system has shown a profit and has enabled prices to be reduced considerably.

Light and Coal Production.—The marked effect of improved lamps upon the production of coal is shown in a recent article in the *Journal of Industrial Psychology*. Research recently carried out by the Institute of Industrial Psychology into the difference made by the use of a lamp giving a more intense light, showed that the production per man was increased from 2.47 to 2.83 tons per shift—an advance of 14.57 per cent. The amount of "dirt" which had to be discarded fell in a marked degree. Upon reverting to the use of the smaller lamp, the amount mined again decreased and the amount of dirt increased.

BUSINESS NOTES.

Bankruptcy Proceedings.—H. Lee, electrician, 29, Providence Street, Farsley, Yorks. (and lately carrying on business in co-partnership with A. W. Verity, at 143a, Leeds Road, Bradford, as Verity & Lee, electrical contractors).—Receiving order made January 22nd, on debtor's own petition. First meeting February 5th, at the Official Receiver's office, 12, Duke Street, Bradford; public examination February 28th, at the County Court, Bradford.

H. South, electrical engineer, 43, Rathbone Place, W.C., and late of 10-12, Garrick Street, Covent Garden, W.C.—Application for discharge to be heard at Carey Street on February 13th.

E. Cookson (W. Turnbull & Co.), automobile, electrical and mechanical engineer, Express Magneto Repair Works, Elizabeth and Charles Streets, Blackpool.—Last day for proofs for dividend, February 9th. Trustee, Mr. C. H. Plant, Official Receiver, 13, Winckley Street, Preston.

Douglas Henry Griffin (22), electrician.—We learn that Griffin, who was recently adjudged bankrupt, but absconded, was last week, at Lancaster Assizes, sentenced to 12 months hard labour for bigamy.

W. Price and A. Greenburgh (W. Price & Co., 29, Russell Street, Plymouth, electricains).—The debtors' statement of affairs shows gross liabilities £652, and assets (book debts—bad—£10 15s.) nil, the deficiency thus being £652. Debtors allege as the causes of failure bad trade and depreciation of stock. According to the Official Receiver's statement, they verbally agreed to become partners in 1919, and Greenburgh's father provided £250 capital then, also £275 later. It was arranged that Greenburgh should draw nothing from the business, and Price £25 per annum, until the firm had become established, the partners being supported by their respective parents. Greenburgh is at present unemployed; Price's wife is stated to have had about £50 when the parties were married five months ago, which has been used by her in purchasing electrical goods to enable her husband to earn a living. The principal unsecured creditor is Greenburgh's father. The public examination takes place on February 9th.

O. Greathead & W. Greathead (Greathead Bros.), electrical engineers and contractors, 50, Burnley Road, Brierfield.—First meeting February 8th, at the Official Receiver's office, Preston; public examination, February 13th, at the County Court House, Burnley.

J. Kaine-Fish, wireless instrument maker, Sempolia, West Green Road, Tottenham, N.—First meeting February 6th, at 26, Russell Square, W.C. Public examination, February 14th, at the Court House, Upper Edmonton.

F. H. Thomas & W. E. Evans (Thomas & Evans), electrical engineers, Salubrious Chambers, Salubrious Place, Swansea.—Trustee, Mr. C. H. Harvey, 3, Goat Street, Swansea, appointed January 26th.

J. E. Rollinson, electrical engineer, 5, Tavistock Chambers, Beastmarket Hill, Nottingham.—Last day for proofs for dividend, February 14th. Trustee: Mr. H. F. Holloway, Bentwick Buildings, Wheeler Gate, Nottingham.

Private Arrangements.—William Henry Baker, Belle Vue House, Penrhiwceiber Road, Penrhiwceiber, and 1, Jeffrey Street, Mountain Ash, ironmonger and electrician.—A meeting of the creditors in this matter was held at Cardiff on January 16th, when a statement of affairs presented showed liabilities amounting to £1,594 and net assets £536, or a deficiency of £1,059. It was reported that the debtor started business in the year 1915, with a capital of £75, borrowed from his brother-in-law. His weekly takings had amounted to about £70, but they had now fallen to about £35 a week. The present position was attributed to loss sustained in consequence of the fall in the price of goods, labour troubles, inability to collect outstanding book debts, sickness of his son, and heavy expenses owing to his illness. It was stated that the debtor was desirous of carrying on the business and of paying a composition if the creditors would grant him time. The debtor's solicitor made an offer of 5s. in the £, and this was considered, but it was felt to be inadequate, and some creditors suggested 10s. in the £. Ultimately a resolution was passed to the effect that the debtor be given seven days within which to find security for the payment of a composition of 7s. 6d. in the £, payable over a period of one, two, and four months, fully secured to the satisfaction of a committee of inspection. It was also agreed that failing security the debtor be called upon to file his petition in bankruptcy, also that a deed of assignment be executed to Mr. S. E. Clutterbuck, of Messrs. Clarke, Dovey & Co., of Cardiff. A representative of the General Electric Co. was also nominated on the committee. The following are among the creditors:—

	£		£
Baxendale & Co., Ltd. ...	108	Falk, Stadelmann & Co. ...	53
Braby, Fred., & Co., Ltd. ...	22	General Electric Co.	93

J. A. Groome, electrician, 17, Windsor Road, Willesden Green, London, N.W.—A meeting of the creditors of the above was held recently, at the offices of Messrs. Wrigley, Lord & Cregan, C.A., 4, Copthall Buildings, London, E.C. In the circular calling the meeting it was stated that the debtor had executed a deed of assignment which provided for a composition being paid to the creditors. Mr. H. Cregan—the trustee under the deed—stated that the liabilities so far as could be ascertained, amounted to £650, while there were also preferential claims totalling £118. The assets were estimated to realise £353. The debtor commenced trading some two to three years ago with a small capital, but money was lent to him by a creditor, who now appeared for £99. A resolution was passed in favour of the meeting being adjourned for fourteen days in order to allow the debtor to find guarantors for a sum sufficient to pay a composition of 10s. in the £.

Company Liquidations.—Wilson Hartnell & Co., Ltd., Leeds.—The statement of affairs issued by the Receiver for the second debenture holders (Mr. P. McCandlish Wilson) shows that as these holders cannot possibly receive payment in full there will be no available funds for the ordinary creditors of the company. The assets included debts £1,809, expected to realise £1,150; stock-in-trade and work in progress (cost price £3,423) estimated to realise £600; goodwill and patterns £250; the total available assets, subject to expenses of realisation being £2,100, less preferential creditors for rent, rates, taxes, wages, &c., £655. The freehold property and machinery attached thereto (deeds deposited as securities) are estimated to realise £4,000. The liabilities are: first debentures and interest, £1,526; bank overdraft, £4,310; second debentures and interest, £4,122; total, £9,958. There is a deficiency of assets to meet the claims of second debenture holders of £4,513, and a total deficiency of the company to meet the claims of creditors of £10,051.

London Electrobus Co., Ltd.—A meeting is called for February 26th, at 175, Piccadilly, W., to hear an account of the winding-up from the liquidator, Mr. T. J. Garlick.

Liverpool District Lighting Co., Ltd.—Winding up voluntarily (all liabilities will be paid in full). Liquidator: Mr. W. L. Jackson, 51, North Street, Liverpool. Meeting of creditors February 12th.

Tofield & Robinson, Ltd.—Winding up voluntarily. Liquidator: Mr. A. C. Ridgway, Exchange Buildings, New Street, Birmingham. Meeting of creditors February 7th.

S. Gillitt & Co., Ltd., 33, Great Market Street, Newcastle-upon-Tyne.—Liquidator, Mr. C. Woollett, Official Receiver, Pearl Buildings, 4, Northumberland Street, Newcastle-upon-Tyne, released January 22nd.

Corona Lamp Works, 10, Ascham Street, N.W.—First meetings of creditors and contributories, February 6th, at Carey Street, W.C.

Dissolutions of Partnership.—R. G. Turner & Co., merchants, of Apollo Electric Motor Horns, Brunswick Works, Brunswick Street, Chorlton-on-Medlock, Manchester.—Mr. S. Nove and Mr. R. G. Turner have dissolved partnership. Mr. Turner will attend to debts and continue the business.

W. Dawson & Co., electrical engineers and sheet metal workers, Bridge End Works, Bollington, Macclesfield.—Mr. W. Dawson and Mr. O. Ratcliffe have dissolved partnership. Debts will be attended to by Mr. Ratcliffe, who will continue the business.

Abbott & Hawkins, electrical and mechanical engineers, 50, Charles Street, Cardiff.—Mr. S. W. Abbott and Mr. W. J. M Hawkins have dissolved partnership. Mr. Abbott will attend to debts and continue the business under the same style.

Trade Announcements.—Messrs. Marshall, Sons & Co., Ltd., of Gainsborough, inform us that their senior representative (Mr. Walter L. Keightley), who lately resided at Nottingham, has now removed to 78, London Road, Reading, Berks.

The Runbaken Magneto Co., Ltd., has opened a branch depôt in Dublin at 17, Clare Street. Telephone number, "Dublin 706." Mr. W. E. Martlew, late of the Birmingham branch, is in charge. A full stock of accessories will be kept, and there is a repair department dealing with magnetos, dynamos and starters, and with accumulator repairs.

Mr. G. A. Gillham, late manager to Mr. F. Geere Howard for 27 years, and Mr. B. Jones, chief electrician for 20 years, have commenced business as Gillham & Jones, electrical engineers, with showrooms at 31, Newman Street, W.1. Telephone No.: "6847 Museum."

Mr. H. Ashdown has recommenced business under the title of H. Ashdown & Co., electrical and wireless engineers, 17, Commodore Street, Stepney, E.1, with works at Harford Street, Mile End, E.1. Telephone: "East 5379."

Messrs. L. G. Hawkins & Co., Ltd., have established their Scottish branch for the trade at 141, Bath Street, Glasgow, under the management of Mr. H. G. W. Haslett. Their various specialities are displayed.

Mr. T. A. Savage, of 115, The Vale, Acton, W.3, who is taking up the supply of wireless apparatus and spare parts, desires to receive price lists.

Messrs. Mawdsley's, Ltd., of Dursley, have appointed Messrs. Abbott & Hawkins, of 50, Charles Street, Cardiff, and Mr. Horsburgh, 217, Coles Lane, Sutton Coldfield, Birmingham, to represent them in South Wales and the Midlands respectively.

Catalogues and Lists.—The Palnut Co., Ltd., 6, Great St. Helens, E.C.3.—Two illustrated pamphlets advertising the "Palnut" safety lock washer, with samples.

Messrs J. H. Collie & Co., 8, Harrington Street, Liverpool.—A pamphlet illustrating and describing a device for taking up extra length in flexibles.

Messrs. Smith & Ansell, Ltd., 109, Gt. Hampton Row, Birmingham.—A well-illustrated list of electric lighting fittings of many patterns: pendants, bowls, standards, lanterns, brackets, &c. Fully priced.

Automatic & Electric Furnaces, Ltd., 173-5, Farringdon Road, E.C.1.—A pamphlet containing particulars of Wild-Barfield electric furnaces for the heat treatment of steels.

Messrs. Allott, Jones & Co., Ltd., Pall Mall, Liverpool.—A booklet containing samples, with prices, of tracing papers of various qualities.

Rose Bros. Electrical Co., Ltd., 25, 26 and 27, Milton Street, E.C.2.—A price list of radio-telephony and telegraphy apparatus.

Messrs. Shenton & Co., Ltd., 11, Moira Terrace, Cardiff.—A net trade price list of electrical supplies, including cables, wires, conduits, switches, lampholders, &c.

Messrs. Haslam & Stretton, Ltd., 11, Windsor Place, Cardiff.—List No. L 1/123, illustrating and describing several types of "Thor" electric safety lamps for use in mines, including the "pillarless" pattern.

Forthcoming Exhibitions.—The following exhibitions are being organised:—

London.—March 4th to 17th, Ideal Homes Exhibition; March 15th to 24th, Photographic Fair; June 1st to 4th, International Mining Exhibition; August 31st to September 22nd, Shipping, Engineering, and Machinery Exhibition.

Hull.—April 20th to May 5th, International Domestic Economy and Trade Exhibition.

Austria (*Vienna*).—March 18th to 24th, International Samples Fair.

Belgium (*Brussels*).—April 9th to 25th, Commercial Fair.

Canada (*Toronto*).—August 25th to September 8th, Canadian National Exhibition.

Czecho-Slovakia (*Prague*).—March 11th to 18th, Samples Fair.

Finland (*Helsingfors*).—July 1st to 7th, International Samples Fair.

France (*Bordeaux*).—June 15th to 30th, Samples Fair.

(*Lyons*).—March 1st to 15th, Spring Fair.

Germany (*Cologne*).—Spring, 1923, Samples Fair.

Italy (*Milan*).—April, Samples Fair.

Jugo-Slavia (*Zagreb*).—March, Samples Fair.

Latvia (*Riga*).—July 22nd to August 5th, Industrial and Agricultural Exhibition.

Madagascar (*Antananarivo*).—August 15th to September 15th, International Commercial Fair.

Spain (*Barcelona*).—March 17th to 28th, International Samples Fair.

Switzerland (*Basle*).—April 14th to 24th, Swiss National Fair.

Trieste.—September 3rd to 24th, International Samples Fair.

For Sale.—By direction of the Disposal Board, Messrs. Fox & Sons will offer by auction, on February 14th and 15th, at H.M. Naval Depôt, Portland, electrical equipment, machinery and miscellaneous stores. Fleetwood U.D.C. Electricity department has for disposal two 60-kW and one 120-kW, 400-V, d.c. generating sets. By direction of the Disposal Board Messrs. Bruton, Knowles & Co. will sell by auction, at the National Shipbuilding Yard, Beachley, near Chepstow, on February 7th, electrical equipment, buildings, furniture, and canteen equipment. (See our advertisement pages to-day.)

Electric Omnibuses for Spain.—*The Times* states that a dozen electric motor-omnibuses, built at Maidstone for Barcelona, were shipped from Dover on Monday.

The Scottish Motor Show.—Among the exhibitors at the Scottish Motor Show, which was opened last week, is the Chloride Electrical Storage Co., Ltd., which is showing numerous examples of accumulators specially designed for different makes of automobiles, battery hand lamps, accumulators for radio purposes, &c.

Callender's Hospital Fund.—The annual report and accounts of Callender's Hospital and Distress Fund were submitted at the general meeting of the Fund, held at the Belvedere Works on Saturday last, Mr. P. Walker (the president) in the chair. During the year 1922 unemployment again caused a decrease of members and of subscriptions, but the company has on this occasion given a special donation of £50 (making £100 for the year). This has enabled the amounts awarded to the various hospitals in the previous year to be maintained. Nearly 300 hospital letters were issued, also letters for special nursing at home, 103 surgical appliances were supplied, and 32 surgical aid letters were issued. Ten patients were sent to convalescent homes, spectacles were supplied in 78 cases, financial assistance was granted in a number of cases of distress, and in other ways excellent work was done. The weekly subscriptions realised £602, which was £143 less than in 1921. The amounts awarded to hospitals and other institutions came to £646, against £661 for 1921. The committee ends its report by looking for a revival of trade and commerce for the nation in 1923, with less unemployment and further success for the fund.

Public Contracts.—British Preference.—The British Empire Producers' Association has, as the result of recent discussions, forwarded a communication to the President of the Board of Trade, asking that a deputation should be received on the need for giving preference to firms employing British Empire labour and materials in connection with all public body contracts. The Association in its letter records its conviction that there are many ways, as well as tariffs, which can be pursued to make preference really effective and to render the Empire self-supporting. It states:—

"First among these is the stopping of the immense wastage of public moneys by contracts placed by Governments and other public bodies with foreign firms, where the money spent is not reproductive in the country or the Empire.

"The most pressing problem facing this country is lack of manufacturing business and consequent unemployment, and the resulting enormous falling away of national prosperity, and it is strongly our view that it is by means of concentrating our own energies and resources in the performance of all our own necessary works this can best be met and overcome.

"It has been urged, not only by the affiliated Associations overseas, but by many bodies of manufacturers and producers in this country, that the matter is one of the greatest moment and there is a very strong feeling that it is one in which the Imperial Government might set an example to all other governments and municipal and public bodies throughout the Empire, by establishing a definite Empire preference in calling for tenders. Since the war public bodies have placed contracts abroad on account of differences in price varying from 5 to 15 per cent. without apparently realising that in so doing they have lost to the country in each case amounts in wages varying from 40 to 80 per cent. of the full amount of each contract, with the result that the heavy burden of unemployment falling directly or indirectly on such public bodies has more than exceeded the 5 to 15 per cent. which they originally saved on the contract price.

"It is suggested that the form that this preference should take would be that an Empire tenderer, using Empire produced material to at least 75 per cent. of the total used, and employing only British Empire labour, should rank, for the purposes of acceptance of the tender, below any foreign tenderer or one not fully complying with the conditions specified, unless that foreign competitor quoted a price at least 15 per cent. lower than the British tenderer referred to."

Mr. H. Baker, secretary of the Midland Branch of the National Union of Manufacturers, has written to the *Birmingham Post* with reference to Sir Eric Geddes's letter to the Prime Minister. He says that the Government has already considered the matter of public contracts in granting facilities under the Trade Facilities Act of 1921, and the objections have been met.

It was thought advisable, when the new Bill was recently under discussion in the House, to obtain a definite pledge from the responsible Minister. Mr. P. J. Hannon, M.P. (a vice-president of the Union and a member of the Midland Council), on December 7th, therefore, asked for an assurance that in the case of guarantees under this Bill a condition should be attached that all contracts must be carried out with British material and British labour. Sir P. Lloyd-Greame (President of the Board of Trade), replied that he agreed entirely with the suggestion, and, as a matter of fact, in all contracts the following provision was inserted:—

"That all plant, machinery, and materials required in connection with the said works shall be purchased in Great Britain at the lowest price (*ceteris paribus*) on a competitive basis, under contracts requiring the contractors to certify on their own behalf, and on behalf of their sub-contractors, that the plant, machinery, or materials to be supplied under such contract will be wholly of British manufacture, and the company shall enforce such stipulations, and report to the Treasury any modification of or failure to give any such certificate."

This reply, says Mr. Baker, will no doubt be regarded as highly satisfactory, and the only thing needed is to see that the procedure laid down is duly enforced. The Advisory Committee, which acts for the Treasury in the matter, has adequate machinery for that purpose.

We have received, too late for publication in this issue, a communication from Mr. G. Wüthrich, of Oerlikon, Ltd., on the subject of "Contracts Sent Abroad."

Rubber Industry.—Mr. C. R. C. Hart, managing director of the Dermatine Co., Ltd., took the chair at a recent meeting of the Institute of Rubber Industry, at which Mr. Herbert Rogers opened a discussion on "The Value of Talking 'Shop' with your Competitor and Others."

New Branch of the E.C.A.—On January 24th a meeting of the electrical contractors of Ealing was held at 1, Sandringham Parade, Ealing Broadway, when officials from the central office of the Electrical Contractors' Association were present. A sub-branch of the Association was formed, comprising electrical contractors in the Ealing area. Mr. A. G. Mead was elected chairman, Mr. J. E. Honar secretary and

treasurer, and the committee consists of Messrs. Paul, Honar, Geoffrey and Hutt. Mr. J. D. Knight, M.I.E.E., chief electrical engineer to the Borough of Ealing, was present, and the proceedings terminated with a dinner provided by the Ealing contractors, at which the president and other members of the central body were entertained.

Applications for British Trade Marks.—Appended is a summary of the recent applications for British trade marks in respect of goods and productions associated with the electrical trades and industries. Individuals and firms desiring to enter an objection to any of the applications have one month in which to do so from the dates given below. In the case of foreign applications the names and addresses of the British representatives to whom the objections are to be sent are also given.

Morsophonola. No. 428,950. Class 8. Electrically-operated apparatus for teaching the Morse code. Walter Grafton and Son, Ltd., Foots Cray Road, Eltham, S.E. January 10th, 1923.

Discol. No. 430,619. Class 8. Wireless telegraph and telephone instruments. Gent & Co., Ltd., Faraday Works, St. Saviour's Road East, Leicester. January 10th, 1923.

Siemens (lettering and design). No. 421,148. Class 4. Electric arc electrodes of carbon. No. 421,149. Class 8. Searchlight apparatus; and No. 428,652. All goods in Class 13. Carl Friedrich von Siemens, trading as Gebruder Siemens & Co., 128-137, Herzbergstrasse, Lichtenberg, Berlin (Marks & Clerk, 57-58, Lincoln's Inn Fields, London, W.C.). January 24th, 1923.

Electricity in Russia.—Mr. E. A. Nikolaef, a Russian engineer, in the *Ekonomitchiskaya Zhisn*, on December 27th, 1922, dealt with the question of "Foreign orders of the Glavelectro and Russian Industry"—the orders placed abroad by the General Electrical Commission.

He states that the production in Russia of turbo-generators of up to 5,000 kW is near its final solution, as it appears that the construction will be carried out by the Petrograd Electrotechnical Trust. More interesting, however, is the problem of the building in Russia of high-speed steam turbines of from 10,000 to 16,000 kW for district generating stations. It appears to be possible to construct turbine parts in Russia. In pre-war times the Franco-Russian and the Baltic Works embarked upon the construction of large steam turbines, which were proposed to be erected in super-Dreadnoughts for 50,000 h.p. (*Borodeno* and others). The more serious question is the possibility of the construction of corresponding generators, because the Russian works have had no experience in this direction. In order to solve the problem it would be necessary to unite the forces of the electrical manufacturing works with the works engaged in the heavy (iron and steel, and engineering) industries, mainly in Petrograd, as already possessing experience in the construction of turbines; but in general this is a matter for the future.

Closely connected with the possibility of building large turbo-generators is the question of boilers and steam-pipe work, the cost of which in gold is said to exceed that of the turbines, and which have hitherto been ordered from abroad. It is now proposed to order abroad 27 steam boilers and pipe-work for the needs of electrification in 1922-23. Most of these boilers are to be on the Garbe system, and only a few of the Babcock & Wilcox marine type for oil fuel stations. In the meantime it has to be noted that various Russian engineering works formerly built boilers of the Garbe type, and approximately of the same superficial heating surface as now proposed, and several such works are enumerated by the engineer. That which is best adapted for the construction of these boilers is the Petrograd Metallurgical Works. The majority of the engineers charged with the erection and working of generating stations, however, are opposed to the orders being executed in Russia.

Luncheon.—A luncheon was given to representatives of the Press by Messrs. Chubb & Sons Lock & Safe Co., Ltd., at the Victoria Hotel on January 25th. Sir George Hayter Chubb, Bart., J.P., the chairman of the firm, presided, and after lunch a film was "screened" showing the production of various types of large safes. The manufacture of doors weighing up to 13 tons was exhibited stage by stage from the production of the steel to assembly. The ingenious mechanism adopted to baffle burglars was of great interest. Sir George facetiously stated that it was the object of his firm to render burglars extinct.

Unemployment.—The number of totally unemployed persons registered on January 22nd was 1,438,800, a decrease of 18,892 on the week, and 384,933 as compared with January 1st, 1892.

The Special Committee of the London County Council on Unemployment reports that the total number of registered unemployed in the London area on January 8th was 158,693 or 35.4 per 1,000 of the population. It is also stated that 250,100 (55.7 per 1,000) persons were receiving poor-law relief on that date.

Australian Tariff Decisions.—The following tariff decisions have been approved by the Customs Department:—Motors, electric, not exceeding ¼ h.p., for manufacture of sewing machines (on security). Item 404, free under the British preferential tariff, free under the intermediate tariff, 10 per cent. Telephone (wireless) receivers. These are receivers of the telephone type used both in wireless telegraphy and telephony. Item 180 (A), free, 5 per cent., 10 per cent. Microphone for radiophone transmitting set. Item 180 (A), free, 5 per cent., 10 per cent.—*Reuter's Trade Service* (Melbourne).

Book Notices.—"Manual of Up-to-date Organisation and the Science and Practice of Costs and Works Accountancy," by G. T. Turner and B. Wood; pp. 192. London: The School of Costs and Works Accountancy. Price 10s. 6d. net.

"Reid's Handy Colliery Guide for Northumberland, Durham, Yorkshire, Cumberland, and Westmorland." Pp. 250 and map. Newcastle-upon-Tyne: Andrew Reid and Co., Ltd.; price 3s. 6d.—This new edition has been carefully revised from official returns and other sources. It gives lists of collieries, managers, agents, &c., and a directory of associations and institutions connected with the coal trade. The legislation section reproduces the Coal Mines Acts and the general regulations as to the installation and use of electricity in mines. Wages, compensation, output, and much other information completes the volume.

Sir Isaac Pitman & Sons, Ltd., have issued a supplementary list of technical, commercial, and other specialised works dealing with matters so far apart as agriculture and millinery. The list includes additions to the "Technical Primers" and the "Common Commodities and Industries" series. A number of alterations in prices is noted.

"Arithmetic for Engineers," by Charles B. Clapham, Hons. B.Sc. Eng. (London). (Third Edition; pp. 491). London: Chapman & Hall, Ltd.; price 7s. 6d. net.—The preface to this edition of one of the most useful of the "D.U." series states that the only addition is a chapter on elementary trigonometry. This occupies 24 pages and explains in a clear and simple way the fundamentals of this important branch of mathematics. The matter on verniers and micrometers which, as extraneous matter, formed an appendix to the second edition, is retained in the same form.

"Telephone Erection and Maintenance," by Herbert G. White, A.M.I.E.E. (Third edition.) (Pp. 144; 48 figs.) London: S. Rentell & Co., Ltd.; price 3s. 6d. net.—In the third edition of this useful handbook for the contractor and wiremen a number of improvements have been effected. The text has been revised, new methods and systems added, and obsolete matter omitted. Many of the diagrams have been re-drawn and new ones added.

"The *Mechanical World* Electrical Pocket Book, 1923." (Pp. 388.) London and Manchester: Emmott & Co., Ltd. Price 1s. 6d. net.—One of the principal features in this edition is a section upon electrical measuring instruments occupying about 13 pages. In this general principles and definite applications are succinctly set forth. The section on plant load and diversity factors is also new material. The notes on mercury vapour rectifiers have been re-written to include results of recent practice. Other new items are those dealing with "Cyc-Arc" welding, and the "Transverter."

"*S.A. Mining & Engineering Journal* Year Book, 1922-23." (Pp. 402.) London: Argus South African Newspapers, Ltd. Price 10s. 6d.—This bulky volume contains a complete history of the various phases of mining and engineering in the Union of South Africa, as well as in other parts of the continent: Congo, Zambesi, &c. One interesting section is that treating of asbestos. It is stated that the output of Rhodesia for one month (September, 1922) was 1,558 tons. The coal industry is reviewed in an exhaustive manner, the system adopted being to take each company's activities, with particulars of production and financial results. The companies' reports and accounts for 1921 are given in most cases.

"Jahrbuch der Elektrotechnik," by Dr. K. Strecker; pp. 232. Munich: R. Oldenbourg, 7s. 6d.

"Les Grands Réseaux de Transport D'Energie Electrique à très haute Tension." Paris: Union des Syndicats de L'Electricité.

"*Journal* of the American Institute of Electrical Engineers." New York: Vol. XLII, No. 1, January, 1923. The Institute; price $1.

"Practical Testing of Dynamos and Motors," by C. F. Smith. Pp. xii+271; figs. 120. Manchester: Scientific Publishing Co.; price 7s. 6d. net.

The Rio Exhibition.—It has been decided to prolong the centenary exhibition from March 31st to July 2nd. This will give more time to those exhibiting nations whose displays have only been recently opened. *The Times* states that the exhibition has been an excellent national advertisement for Great Britain, and it is hoped that the British section will be continued.

Electrical Plant for Buenos Aires.—Electrical plant, machinery and fittings will shortly be required in connection with the considerable building extensions about to be undertaken by Gath & Chaves, Ltd., a British concern closely connected with Harrods (Buenos Aires), Ltd. Other large establishments in Buenos Aires to install similar equipments in connection with extensions upon sites recently purchased are J. Voss y Cia., and Casa del Acqua.—*Reuter's Trade Service* (Buenos Aires).

Tramway Workers' Wages.—At the suggestion of the Electrical Trades Union the London County Council has appointed Mr. Roger T. Smith, past president I.E.E., to arbitrate upon the rates of pay of certain employés in the rolling stock branch of the Council's tramway department.

A German Scheme for Baku.—It is reported in Berlin that the Siemens-Schuckert Co. has concluded a preliminary agreement with Soviet Government with regard to the preparation of a scheme for the construction of a generating station and electric tramways at Baku. A German engineer has been dispatched to Baku in connection with the project.

Capital Transactions in the German Electrical Industry.—As has been mentioned on various occasions, in the past few months very considerable augmentations of capital were carried out in the German electrical industry in 1922, particularly in the matter of hydro-electric works and other generating stations.

The Siemens group is one—if not the only one—of the big manufacturing undertakings which did not proceed with any changes in capital last year. As is pointed out by a German newspaper, this group naturally was not inactive in 1922, having formed a Japanese company and taken a lively interest in Russia. The group now proposes to give notice of repayment of its loans which, if all comes into consideration in this respect, would represent 300,000,000 marks. Most of the other companies which are now interested in the redemption of gold loans by means of paper marks have previously raised money by the issue of new shares; but the Siemens group has not taken such a step. It is assumed that the financial strength of the group is explained by its participation in the Siemens-Rhine-Elbe-Schuckert Union, which has permitted, among other matters, of stocks being kept at a minimum level. As to the Union itself, all reports of a proposed capital augmentation have hitherto proved to be incorrect.

The A.E.G. is also associated with a trust in its connections with the Felten & Guilleaume Co., the Lauchhammer Iron Steel Co., and the Otto Wolff-Phœnix Steel group, as well as with other undertakings. During 1922 the capital of the A.E.G. was increased to 1,400,000,000 marks, this being more than that of any other individual joint stock company in Germany, whereas the share capital of the Siemens and Halske Co. has remained at 260,000,000 marks. Another group, in which both the A.E.G. and the Siemens group are interested, comprises the Berlin-Hagen Accumulator Co., the Osram Co., and the Wireless Oversea Communication Co., each of which made large increases in its capital last year. Considerable augmentations of capital also took place in the case of the companies which are associated with the A.E.G. or the Siemens group independently.

The Bergmann Electricity Works Co., whose share capital was raised to 165,000,000 marks, is the only large manufacturing undertaking in Berlin which does not belong to any group. So far all rumours of a proposed development into a coal and steel trust, perhaps by association with the Klöckner coal and iron trust, have turned out to be untrue. The connection of the Bergmann company with the Siemens group, which is no longer represented on the board of the former, is still very slack. A rapid bound in the capital from 48,000,000 to 200,000,000 marks was taken by the Dr. Paul Meyer Co.

The City of Berlin continues to occupy the leading position from the standpoint of electrical manufacturing on a large scale by big works. In addition there are other centres of production, as, for instance, Saxony (where the Saxony Light and Power Co. has experienced a rapid development. This company now has a share capital of 247,000,000 marks, which sum represented the capital of the A.E.G. between 1917 and 1920. The Poege Co. also raised its capital to 86,000,000 marks in 1922, while four new electrical manufacturing concerns were established in Chemnitz, Leipsic and other parts of Saxony last year. In the district of Frankfort-on-Main there is the Lahmeyer Co., but its dynamo works was transferred to the A.E.G. years ago. The Emag Co. is also located in this city, while three new concerns were brought into existence last year.

Catalogues Wanted in Siam.—A maintenance engineer on the Siamese State Railways is desirous of receiving catalogues of various classes of goods, including wrought-iron tubes, valves, general hardware, electric light fittings, &c. When submitting particulars of his requirements to headquarters he is handicapped by reason of his inability to refer the authorities to catalogues illustrating the goods requisitioned. The possession of such lists in duplicate would considerably facilitate his work. His name and address and those of other maintenance engineers of the Siamese State Railways can be obtained from the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Electricity Supply Rifle League.—The annual meeting of the League will be held early in February. The hon. secretary will be pleased to hear from any new clubs formed in connection with Metropolitan undertakings with a view to their becoming members. The final results for the year 1922 are as follows:—Central 584, Fulham 548; Central 582, Metropolitan 575; Central 580, St. James's 535; City Co. 588, Fulham 538; City Co. 588, St. James's 565; City Co. 583, Shoreditch 574; County Co. 570, Metropolitan 564; County Co. 576, Shoreditch 582; Shoreditch, 582, Fulham did not shoot; County Co. 571, St. James's did not shoot; Shoreditch 584, Metropolitan 576; Shoreditch 578, St. James's did not shoot; Metropolitan 578, St. James's did not shoot; Metropolitan 576, Fulham did not shoot; St. James's 567, Fulham did not shoot; St. James's 558, Hackney 537. Shoreditch headed the League with 26 points out of a possible 28.

In connection with the tenth annual distribution of prizes the members of the Hackney Club held a whist drive on January 26th with their friends. Mr. F. G. Taylor carried out the duties of M.C., and at the conclusion of the drive announced the winners, to whom the Mayoress handed the prizes.

Federation of British Industries and Labour.—We understand that the Federation of British Industries has for some time past been the object of attacks on the ground that it is conducting a campaign for the lengthening of working hours and the reduction of wages. In view of these attacks the Federation wishes to state categorically that any such suggestion is utterly untrue. The Federation is precluded by its constitution from taking any part in regulating the relations between employers and employed. It deals solely with commercial, financial and technical questions, with regard to which it promotes the interests of its members, and therefore also of their workpeople. Questions affecting the relations between employers and employed are dealt with by other and completely independent parties.

Chinese Notes.—The Ministry of Communications has registered the Shanghai-Paoshan Tramway Co., Ltd., at the recommendation of the Civil Governor and Defence Commissioner of Shanghai.

A shipment of tramcars ordered by the Peking Tramway Co. has arrived in Peking, and is temporarily stored on the ground before the Forbidden City.

The Kweisui Telephone Co., at Kweisui, with a capital of $50,000, has been registered by the Ministry of Communications.

The plant of the Chen Hwa Electric Co. is being built at Changchow and the work is expected to be completed next spring. German machinery will be used. The capital is $500,000. The Li Sun Cotton Seed Oil Factory and the Li Ming Cotton Mill with about 15,000 spindles, are connected with the electrical company.

The Canton Electric Co. has placed an order with Anderson, Meyer & Co. for a 5,000-kW machine, the cost of which will be more than $700,000.

Scottish Electrical Workers' Wages.—The dispute between the employers in the Scottish electrical power industry and their employés has been referred back to the Scottish Joint Industrial Council by the National Council for Wages and Conditions. Failing a settlement the dispute will be adjusted by arbitration. The employers, including municipalities, are now asking for a cut of 1d. per hour on February 1st and a similar reduction on April 1st. The unions have offered to accept a compromise of 4s. a week cut. Five thousand general and semi-skilled men are affected.

Copper and Lead Prices.—Messrs. F. Smith & Co. report, January 30th:—Copper (electrolytic) bars, £73, 45s. increase; ditto ditto, sheets, no change; ditto ditto, wire rods, £83, 45s. increase; ditto ditto, h.c. wire, 10 5-16d., ¼d. increase.

Messrs. James & Shakespeare report, January 31st:—copper bars (best selected), sheet and rod, no change; English pig lead, £29 15s., 20s. increase on the price quoted last week.

LIGHTING AND POWER NOTES.

Australia.—TASMANIA.—The Premier and Minister of Works has circulated a statement regarding the progress of the Government's Great Lake hydro-electric scheme. This shows that the actual total capital expenditure on the works to June 30th last was £2,786,957. It is anticipated that by June 30th, 1926, the total capital invested in the scheme will amount to £3,100,000. For the year 1922-23 it is estimated that the demand for power will be 46,450 h.p., with a saleable surplus of 10,000 h.p., while for 1925-26 it is estimated that the demand will be 52,750 h.p., and the saleable surplus 3,700 h.p. The Upper Shannon portion of the Great Lake scheme is to be put in hand immediately. This is expected to make available an additional 13,000 h.p. at a cost of £400,000.—*Reuter's Trade Service* (Melbourne).

Brazil.—SAO PAULO.—Important new electrical construction is contemplated by the Companhia Paulista de Forca é Luz. The new work includes the installation of new hydro-electric plant at the power station of Bauru, with a capacity of 2,000 h.p., a 60,000-V transmission line from Salto do Avanhandava, on the Tiete River, to Bauru; and three sub-stations, one of 1,000 kW and two of 2,000 kW. Additional distributing lines will also be erected.—*Reuter's Trade Service* (Rio de Janeiro).

PUERTO ALEGRE.—The State Government of Rio Grande do Sul has granted a concession for the provision of hydro-electric

power to the city of Puerto Alegre and vicinity. Tenders for construction will be received up to October 10th, 1923, foreign contractors being free to participate. The proposed site for the hydro-electric plant is on the Rio Jacuhy, in the municipality of Saledade, situated about 140 miles north-west of the city of Puerto Alegre. According to present estimates, a minimum of 40,000 h.p. can be developed.—*Reuter's Trade Service* (Rio de Janeiro).

Cardiff.—Price Reductions.—The following reductions have been made in the charges for electricity: lighting, from 5¾d. to 5½d. per kWh; power (flat rate), from 2¾d. to 1¾d. per kWh. It is not proposed to make any reduction in the charges for heating energy.

Canvey Island.—Proposed Electricity Supply.—Messrs. H. B. Underwood & Co., of Southend-on-Sea, have under consideration the question of supplying electricity to the island.

Continental.—France.—The Société d'Etudes des Chutes de la Cure et des Chemins de Fer électriques de l'Yonne (Cure falls and Yonne railways schemes) has applied for a concession for the distribution of electrical energy for public services in the Yonne and Nièvre. A power station with a capacity of 6,000 kW has already been erected at Langres, and the concession includes the linking-up of this station with those of the Cure by a 60,000-V transmission line. The concession includes the four departments of the Yonne, Nièvre, Côte-d'Or, and Haute Marne. The estimated cost is 23,300,000 fr. The concession is conditional on a minimum of 35 km. of railway line being constructed within five years and 150 km. within ten years. Possible expansions of the scheme are the linking of the Cure stations with those in the neighbourhood—Montereau, Troyes, Langres, Dijon, Auxerre, and Garchizy, near Nevers. As a result of these plans, applications for State concessions have already been lodged for a 20,000-volt line from Sens to Auxerre by two companies; and for another running from Langres to Chatillon-sur-Seine, Montbard, Cure, and Auxerre. It has been decided to adopt the 3-phase system.

Austria.—In order to facilitate the completion of the hydro-electric station now in course of erection on the Teigibsch River and to commence the other hydro-electric stations projected in its programme, the Steirische Weag Aktien Gesellschaft has succeeded in arranging a loan of 5,000,000 fr. with a Swiss banking group, subject to a guarantee being given by the Steirischen Landtag. This has been secured, and the work will be undertaken shortly.

Exeter.—Loan.—The Electricity Committee has recommended that application be made to the Electricity Commissioners for sanction to the borrowing of £10,000 for mains and services.

Price Reductions.—It is also recommended that the charges for electricity for lighting, power, and heating purposes be reduced to 62½ per cent. above pre-war charges, and that the price of energy for tramways supplies be reduced from 2¼d. to 2d. per kWh.

Kingston-on-Thames.—New Plant.—The Town Council has decided to install additional plant at the electricity works at a cost of £15,500.

Price Reduction.—The charges for electricity are to be reduced by ¼d. per kWh.

London.—The Renewal of Fuses.—In November, 1921, the London County Council drew the attention of the Electricity Commissioners to the fact that certain electricity supply authorities were making a practice of charging for the renewal of safety fuses on consumers' premises, and asked that steps be taken to protect consumers against this. The Council, having been informed that only two companies make such a charge, and that this is only done where the fuses have blown through consumers' negligence, has decided to take no further action at present.

Musselburgh.—Electricity Supply.—The Edinburgh Electricity Committee is preparing a scheme for supplying the town with electricity. It is proposed that the electricity shall be supplied from the Portobello power station. The current will be transmitted at 33,000 V and transformed down by the local electricity supply company. In all a total of 19 miles of transmission lines will be required. The estimated cost of the scheme is £32,000.

New Zealand.—Hydro-Electric Developments.—It is planned to carry out developments of hydro-electric resources to the extent of £1,075,000 during the present year, as compared with £834,000 last year. The largest item is £420,000, which is to be expended on the Mangahao scheme. Other developments are:—Lake Coleridge scheme, £275,000; Horahora scheme, £170,000; Arapuni scheme, £130,000; and Waikaremoana scheme, £100,000. Both the Lake Coleridge (12,000 h.p.) and the Horahora (8,400 h.p.) schemes paid all charges during the year ended June last and provided a margin for the reduction of the accumulated deficit. The Arapuni scheme has to be developed as a whole (36,000 h.p.). Therefore, until the demand reaches this figure, it will be unremunerative. A contract has been made with the Auckland Electric Power Board by which the Board agrees to take a supply of at least 20,000 h.p. by 1928. The work upon the Mangahao scheme has been well advanced—it is proposed to produce 24,000 h.p. by this development.

Northern Ireland.—The Bann Power Scheme.—Mr. James D. Caruth, president of the Ballymena Chamber of Commerce and member of the local Urban Council, has announced that developments with regard to the River Bann electrical power scheme are progressing satisfactorily, and that it is hoped to introduce a Bill next month in the Northern Ireland Parliament for the erection of a power station and the provision of necessary turbines on the river at Carnoe.

Cootehill (Co. Cavan).—*Electricity Supply.*—The Urban Council has approved of an agreement with Messrs. S. Close and Co., electrical engineers, Dublin and Belfast, for the lighting of the town by electricity for ten years at the price of 1s. per kWh.

Rochford (Essex).—Loan.—The Board of Guardians has applied to the Ministry of Health for a loan of £3,300 for an electric lighting installation at the poor law institution.

Seaton (Devon).—Special Order.—Application has been made to the Electricity Commissioners by Brigadier-General G. B. Smith, C.B., for a Special Order authorising him to supply electricity for all purposes within the urban district, and parts of parish of Axmouth and the borough of Colyford.

Skipton.—Loan Sanctioned.—The District Council has received sanction from the Electricity Commissioners to borrow £2,500 for switchgear and transformers. The Yorkshire Electric Power Co. has written stating that it is in negotiation with the Keighley Corporation for terms of supply by the latter, and that when these terms are arranged the company will submit the draft agreement to the District Council.

South Africa.—Johannesburg.—The Town Council has under consideration three schemes submitted by the general manager of the Electricity and Tramways Department for dealing with the electricity supply problem of the city. The first scheme is to erect a power station at Klipspruit at a cost of £860,000; the second, to utilise the old gas engine station as an engine room and erect a new boiler-house at a cost of £490,000; the third, to add to existing plant at a cost of £400,000. The Council has decided to obtain further information before adopting one of these schemes.

Southampton.—Extension of Electricity Supply.—The Corporation has been approached by the Southern Railway for an electricity supply to Redbridge, where a large permanent-way works is being erected. Redbridge is outside the town boundary, and the Corporation has asked the South Stoneham Rural Council (the adjoining authority) for permission to lay the cables in the district.

Stevenage.—Electricity Supply.—The Stevenage Lighting and Power Co. has applied to the Electricity Commissioners for consent to establish a generating station in the town.

Swansea.—Electricity Extensions.—The Town Council has decided to supply the Killan, New Dunvant, and Western Gas Co. Collieries with power at an initial plant cost of £14,000.

Westgate-on-Sea. — Order Revoked.—The Ministry of Transport has revoked the Westgate and Birchington Gas and Electricity Act, 1913, giving power to the Westgate and Birchington Gas and Electricity Co. to supply electricity in the parish and to Birchington.

Wirral.—Application for Revocation of Order.—The Rural Council has applied to the Electricity Commissioners for the electric lighting powers granted to the Heswall Power Co. to be annulled, owing to the works authorised not having been carried out.

TRAMWAY AND RAILWAY NOTES.

Argentina.—Tucuman.—The Compañia Electrica del Norte, of Tucuman, has received permission from the Provincial Government to extend its tramway lines in three directions, and will shortly purchase plant and material for the purpose. —*Reuter's Trade Service* (Buenos Aires).

Australia.—Western Australia.—The report upon the Government Tramways for the year ended June 30th last shows that the total earnings amounted to £248,463, as compared with £224,892 in 1920-21. Working expenses amounted to £209,104, as against £204,459, giving an increase in gross profit from £20,433 to £39,259. Although capital charges amounted to more than those of the previous year, the net result was a profit of £3,835, as against a loss of £9,334 in 1920-21.

Canada.—Railway Electrification.—The engineers who investigated the possibilities of electrification of the Temiskaming and Northern Ontario railway have reported in favour of the undertaking. They recommend the electrification of the main line from North Bay to Cochrane (252 miles), the Iroquois Falls sub-division (7 miles), and the Porcupine subdivision (33 miles), as providing a sound and self-supporting investment for the capital funds of the province in a further development of Northern Ontario. The estimated cost of the project is $11,215,000. The commission operating the system for the Government, however, will make further investigations before starting work on the scheme. As a first

step the Government will acquire a title to the undeveloped water-power of several rivers along the route of the railway.—*Reuter's Trade Service* (North Bay, Ontario).

Continental.—France.—The question of the electrification of the whole of the French railway system is being studied by the Parliamentary Commercial Committee, presided over by M. Levy, Senator. Emphasis is laid on the national character of the scheme, and also the necessity for close collaboration between the electrical companies, the railways and the Government. This is to be put into practice by the formation of a sub-commission composed of members of Parliament, business men and qualified electrical engineers, who will prepare a report dealing with the practical side of the question for submission to the Committee.

Switzerland.—A loan of from 200 to 250 million fr. is being issued to provide funds for the electrification of the Swiss railways.—*Reuter's Trade Service* (Paris).

Germany.—The new Berlin "North-South" tube was officially opened on January 29th. The new line passes under the business quarter and links the suburbs with the principal shopping districts. The total cost of the tube is understood to have been 3,000,000,000 marks.

Edinburgh.—Proposed New Routes.—The Tramways Committee has referred to the tramways manager for consideration and report, proposals for extending the tramways from Hope Park Terrace, along Melville Drive to Tollcross, from Gorzie Road, along Chesser Avenue to Slateford Road, from Craiglockhart to Colninton Village, and from Slateford to Juniper Green.

Guildford.—Railway Electrification.—The Southern Railway Group has decided on the electrification of the routes between London and Guildford as an immediate measure of relief for unemployment. By one route the line is already electrified as far as Surbiton and by the other as far as Claygate. The work is to be put in hand immediately.

London.—Tube Extension.—An additional track and platform are to be laid down at Golder's Green Station, and, with the opening of the Hendon and Edgware extensions, the new platform arrangements will permit of 28 trains an hour between London and Golder's Green each way, instead of 18 per hour.

Middlesex.—An important decision was arrived at by the Middlesex County Council on January 25th, when it was resolved to agree in principle that a new lease of the County Council light railways be granted to the Metropolitan Electric Tramways Ltd., to supersede the existing agreements for lease, and to operate from January 1st, 1923, until December 31st, 1951, at an annual rental of £110,000. This will result in an immediate increase in rental of £15,000.

Bank Station Improvements.—The Underground Electric Railway companies have decided to substitute three escalators for the lifts at present in use. It is stated that the new system will be capable of dealing with 40,000 passengers per hour. The contract has been placed with Messrs. Waygood-Otis, Ltd., and work on the escalators has already commenced. The old type of booking-office is to be removed and the "Passimeter" system introduced.

Accident.—A L.C.C. tramcar, when turning a bend at the Obelisk, Blackfriars Road, on January 29th, jumped the points and ran into another tramcar. Passengers of both cars were shaken but no one was injured. The car, which left the line, was badly damaged, the chassis being strained and twisted.

Nottingham.—Track Renewals.—The Tramways Committee has recommended that the tramway track in London Road be renewed at an estimated cost of £16,000.

Sweden.—Sundsvall.—H.M. Consul at Stockholm states that a company with a minimum capital of 750,000 kronor is reported to have been formed at Sundsvall, for the construction of an electric tramway from the town of Sundsvall to the suburb of Gangviken.

Wigan.—Track Renewals.—The tramway track between Market Place and New Springs is to be relaid, at an estimated cost of £29,000, broad gauge being substituted for the present narrow gauge.

TELEGRAPH & TELEPHONE NOTES.

Australia.—Association of Radio Apparatus Manufacturers.—For the protection of their interests and the furtherance of radio-telegraphy and telephony in the Commonwealth, Australian radio apparatus manufacturers have formed themselves into an association. Mr. G. A. Taylor, a prominent radio expert, has been elected president.

France.—Ships' Radio Equipment.—A severe criticism is made by the *Radio Revue* of the French Government's regulations for the use of wireless aboard French mercantile ships and the selfish ignoring of their obligations by French shipowners and shipping companies. The French arrangements are declared to be ten years behind the progress of radio-telegraphy. The apparatus is said to be obsolete and inefficient. The most luxurious of French mail boats have to dispense with Press messages, even on voyages of two months' duration. These strictures, it is to be observed, do not apply to the French navy, which is said to be abreast in the matter of progress, with the navies of other countries.

Holland.—Anglo-Dutch Convention.—The convention regulating telephonic communication between Holland and Great Britain was ratified at the Dutch Foreign Office on January 23rd.—*Reuter* (The Hague).

Radio-telegraphy.—New Service.—Marconi's Wireless Telegraph Co. has introduced a special week-end wireless letter service to the United States at the rate of 3d. per word without minimum. Messages must reach Marconi House before midnight on Saturday and they will be delivered in New York City on the following Monday morning. Telegrams for destinations beyond New York will be forwarded without extra charge.

Imperial Wireless Chain.—It was announced this week that the Committee appointed to consider the question of the Imperial Wireless Chain has prepared its report which will be presented to the Cabinet immediately. Report has it that the Committee favours private rather than national enterprise.

Radio-telephony.—Conference of Amateurs.—At a meeting of delegates from local bodies affiliated with the Radio Society of Great Britain on January 24th, the manager of the British Broadcasting Co. (Mr. Reath), said that although the company's expenses were very heavy its only sources of revenue were the royalties on the receiving sets sold and a percentage of the broadcasting licence fees. A delegate suggested the formation of an English Radio Relay League to enable persons holding transmission licences to help one another in transmission, to collect data, &c. Mr. P. R. Coursey said that it would be useful to arrange for certain stations to always "listen in" for amateur American stations; this would permit valuable information on the subject to be collected.

Music Licences for "Broadcasting" Reception.—Many novel points of a legal nature have been raised since "broadcasting" commenced, and the latest is whether a music licence is necessary for a place in which concerts provided by a broadcasting station are given. At Oswestry, on January 26th, the magistrates dealt with an application of this nature, and acting on a precedent set by a London magistrate held that such premises should be licensed.

Proposed Inspection.—Those who are interested in the question of "broadcasting" have wondered how the regulations with regard to licensing are to be enforced. Now, however, the Postmaster-General has stated that surprise visits of inspectors will be made to the premises of those in possession of receiving sets and where these are being used without a licence prosecution will follow. It is proposed that the duties of inspection shall be carried out by the existing staff and not by specially-appointed officials.

Siam.—Radio Communication.—The permission granted by the Siamese Government to vessels equipped with wireless telegraphy temporarily to communicate with the wireless station in Bangkok from Koh-Si-Chang on account of the submarine cable being out of order, has been withdrawn. The vessel supplied by the Siamese naval authorities, which has for some time past been anchored at Koh-Si-Chang for this purpose, is regarded by the authorities as providing a satisfactory wireless service.—*Board of Trade Journal.*

The Telephone Service.—Extension of London Area.—The London Telephone Area has been extended to include Bushey Heath, Elstree, Hatch End, Hayes, Pinner, and Stanmore. London telephone subscribers should in future quote the name of the exchange and the number of the wanted subscriber when making calls to these exchanges, and should no longer pass calls to them *via* "Toll."

CONTRACTS OPEN AND CLOSED.

(The date given in parentheses at the end of the paragraph indicates the issue of the Electrical Review *in which the "Official Notice" appeared.)*

OPEN.

Australia.—Melbourne.—Melbourne and Metropolitan Tramways Board. March 28th. Manual control gear and switchboards for rotary converter sets. Mr. W. O. Strangward, secretary, 673, Bourke Street, Melbourne.

Victorian Railway Commissioners.—February 28th. Electric train lighting equipment (axle generator system).*

March 14th. Twenty-five dwarf electric signal mechanisms.*

Three-phase, a.c. motors, starting apparatus, and accessories for the Newport workshops. The date for the receipt of tenders has been extended from January 31st to February 28th.*

Postmaster-General's Department. February 21st. Telegraph apparatus. February 22nd, switchboard parts. March 1st, telephone and telegraph parts. March 16th, telephone and switchboard parts and wires. March 21st, testing and protective apparatus. (January 19th.)

Sydney, N.S.W.—February 26th. Department of Public Works. Two electrically-driven stiff-leg derrick cranes for the Cordeau Dam.*

April 30th. City Council. Protective apparatus for the Pyrmont power house.

Hobart (Tas.).—April 9th. Postmaster-General's Department. Telegraph and telephone material.

Belfast.—February 19th. Electricity Department. H.p. 3-phase, 6-core, split conductor cables. (See this issue.)

Belgium.—February 8th. Municipal authorities of Schaerbeek, Brussels. 1,000 metres of l.p. armoured cable, 3 × 100 × 70 mm.; 2,000 metres ditto, 3 × 70 × 50 mm.; 3,000 metres ditto, 3 × 50 × 35 mm.; and 12,500 metres of h.p. armoured cable, 3 × 25 mm. Particulars from Service de l'Electricité, Hôtel Communale, Schaerbeek, Brussels.

February 14th. Belgian Office de l'Electricité, 25, Rue de la Charité, Brussels. 75,000 porcelain insulators, in five lots.

Bulgaria.—Sofia.—February 19th. Bulgarian Direction of Posts, Telegraphs and Telephones. Batteries and telephone material.*

Chile.—Santiago.—April 10th. Chilean State Railways. Electrical material.*

Clacton. — March 7th. Electricity Department. One 340-b.h.p. Diesel engine, one 225-kW multipolar shunt-wound generator, cooling plant, steel structure and pipework. (January 26th.)

Dewsbury.—February 21st. Town Council. Pumps and motors for the sewage disposal works. James Diggle & Son, consulting engineers, 14, Brown Street, Manchester, or from Mr. H. Dearden, borough engineer, Dewsbury.

Eastbourne.—Electricity Department.—One 200-V single-phase, motor-driven, centrifugal boiler feed pump. (See this issue.)

Edinburgh.—February 13th. Tramways Department. Twenty-four air brakes suitable for tramway cars. Forms from manager.

Egypt.—Cairo.—February 7th. Ministry of the Interior. Stores, including electrical goods, for 12 months for the Prisons Department.*

Zagazig.—February 15th. Municipal Council. Two 20-kVA single-phase transformers.—*Reuter's Trade Service* (Cairo).

Hull.—February 7th. Refuse Sub-Committee. Electric lighting installations, &c., for the Scarborough Street and Chapman Street Depôts. Specifications from the City Architect's department.

Ilford.—February 10th. Uroan District Council Electricity Department. E.h.p. and l.p. cables, feeder pillars and stoneware ducts. (January 26th.)

Leicester.—March 12th. Sewage Works and Farms Committee. Designs and quotations for steam, electrical or other type pumping machinery in connection with the sewage disposal of the city. (January 26th.)

London.—St. Pancras.—The Electricity Committee recommends that tenders be invited for two 1,000-kW motor converters for King's Road station.

London County Council.—February 19th. L.p. electric cables, overhead electrical equipment. (See this issue.)

Stepney.—March 1st. Electricity Supply Committee. River-water screening apparatus. (See this issue.)

Londonderry.—February 28th. Electricity Department. Two water-tube boilers, with superheaters, economisers, stokers, steam and feed piping, coal elevators, &c. (See this issue.)

Manchester.—February 13th. Tramways Committee. Portable loader. Mr. H. Mattinson, general manager, Corporation Tramways, 55, Piccadilly, Manchester.

February 16th. Electricity Committee. Six months' supply of electricity meters, potential and current transformers, and time switches. (See this issue.)

Middlesbrough.—February 16th. Electricity Department. Twelve months' supply of a.c. meters. (See this issue.)

New Zealand.—Wellington.—February 27th. Public Works Department. 110,000-V insulators in connection with the Mangahao power scheme.*

March 27th. Lightning arresters.*

March 20th. 110 galvanised steel transmission-line towers complete.*

February 20th. Posts and Telegraph Department. 3,000 switchboard plugs.*

March 20th. 400 miles h.d. copper wire.*

Carterton.—March 31st. Wairarapa Electric Power Board. 11,000-V switchboard. Mr. P. H. Smith, manager, Carterton.

Pontllanfraith, Mon.—February 15th. Mynyddislwyn Urban District Council. Overhead distribution line, cables, services, two 75-kVA transformers, 11,000-V and 400-V, 3-h.p. switchgear. (January 26th.)

Skipton.—February 5th. Electricity Department. E.h.p. and l.p. switchgear and transformers. (January 19th.)

South Africa.—Johannesburg.—March 5th. Municipal Council. Tramway spares.*

Port Elizabeth.—April 16th. Municipal Council. One 3,000-kW turbo-alternator, boilers, coal hoppers, coal conveyor, boiler house, steam and feed-water pipes, &c.*

Cape Town.—Electricity Department. March 23rd. Two-phase induction voltage regulator.*

Stoke-on-Trent.—February 7th. Electricity Department. Two steam jet air pump equipments; 18 months' supply a.c. and d.c. meters. (January 26th.)

Tynemouth.—February 28th. Electricity Department. Switchboards for sub-station, transformers. (See this issue.)

Uruguay.—Monte Video.—March 15th. State Electricity Works, 1,500 d.c. meters and accessories, 8,500 a.c. meters, &c.* March 10th. 66,000 metres of h.p. cable and accessories.*

Warrington.—February 19th. Electricity Department. L.p. lead-covered cable; transformers. (January 26th.)

*A copy of the plan, specification, and conditions of tender, &c., can be inspected at the Department of Overseas Trade (Inquiry Room), 35, Old Queen Street, S.W.1.

CLOSED.

Australia.—Sydney.—Burrinjuck hydro-electric scheme.—The New South Wales Department of Public Works has received tenders from six firms for turbines and generators in connection with the above scheme at prices ranging from £24,127 to £48,254. The quotations submitted were considerably lower than those of 1920. No decision, however, can be reached until details are available from the Agent-General by mail of the offers received by him, as tenders were received both in Sydney and London.—*Commonwealth Engineer.*

Barking.—Messrs. C. A. Parsons & Co., Ltd., have secured the contract for the steam turbines and 3-phase alternators to be erected at the new Barking power station of the County of London Electric Supply Co., Ltd. The total output of the new plant will be between 90,000 and 100,000 kW.

Belgium.—Five Belgian, two Swiss, and one French concerns submitted tenders last week to the municipal authorities of Saint Gilles, Brussels, for the supply of 1,500 amp.-hour meters, the lowest offer being that of W. J. Stockvis, of Ixelles.

For 10,000 metres of d.c. armoured cable for voltages below 750, eight tenders were received—four Belgian, two German, and one each French and Italian. The lowest offer was that of the Bornheim Co., of Brussels.

Dundee.—Contracts for cables have been placed by the Corporation Electricity Committee, all the successful firms being British. In several cases German offers were the lowest, and in one case the German was lowest, a French offer second, and a British offer third.

London.—Lewisham.—Board of Guardians. Accepted:—
Electric lifts for the hospital (£1,375).—Medway's Safety Lift Co., Ltd.

Stepney.—Electricity Supply Committee.
1,000 25-amp. fuse boxes (£167).—General Electric Co., Ltd. (Accepted.)
500 50-amp. ditto (£104).—Reason Manufacturing Co., Ltd. (Accepted.)
Chequer plating for flooring at Limehouse generating station (£281).—Drew-Bear, Perks & Co., Ltd. (Recommended.)

Underground Electric Railways Co. of London. Accepted:—
Three escalators for the Bank Station of the Central London Railway, £29,650; and four escalators for the City & South London Railway, two at Clapham Common Station and two at Stockwell Station, £34,865.—Waygood Otis, Ltd.

New Type of Tram-Car.—The New York Railway Co., New York City, is putting into service a number of street cars equipped with the "pay-as-you-leave" feature which has previously been tried out in a limited way by that company. Turnstiles register the number of passengers as they enter the car, and automatically close the doors against the further entry of passengers when the capacity of the car has been reached. At the same time a "full car" electric sign is illuminated at each end of the car. As passengers leave the car, the arrangement automatically provides for admitting additional persons. There are turnstiles at both ends of the car which permit of free entrance, but require the deposit of a fare before the passenger can leave the car. The car is of the "one-man" type.—*Railway Review.*

FORTHCOMING EVENTS.

Institution of Electrical Engineers.—Tuesday, February 6th. At the Hotel Cecil, Strand, W.C. At 7 p.m. Annual dinner and re-union.

INFORMAL MEETING.—Monday, February 5th. At the Institution, Victoria Embankment, W.C. At 7 p.m. Discussion on "The Supply of Steady d.c. for Telephonic and other Purposes," to be opened by Mr. J. Coxon.

(Wireless Section).—Wednesday, February 7th. At the Institution, Victoria Embankment, W.C. At 6 p.m. Paper on "The Measurement of the Electric Intensity of Received Radio Signals," by Mr. J. Hollingworth.

(North-Western Centre).—Tuesday, February 6th. At the Engineers' Club, Manchester. At 7 p.m. Informal meeting. Discussion on "Power Circuit Interference with Telegraphs and Telephones," to be opened by Mr. S. C. Bartholomew.

(North-Midland Centre).—Tuesday, February 6th. At the Metropole, King Street, Leeds. At 7 p.m. Paper on "The Maintenance of Voltage on a d.c. Distribution System by Means of an Automatic Sub-station," by Mr. P. J. Robinson.

(Liverpool Sub-Centre).—JOINT MEETING WITH THE LIVERPOOL ENGINEERING SOCIETY.—Wednesday, February 7th. At the Royal Institution, Colquitt Street. Paper on "The Electrical Propulsion of Ships," by Mr. R. S. Johnson.

(Dundee Sub-Centre).—Thursday, February 8th. At the University College, Dundee. At 7.30 p.m. Paper on "High-voltage Transmission by Underground Cables," by Mr. A. M. Taylor.

(Western Centre).—Monday, February 5th. At the South Wales Institute of Engineers, Park Place, Cardiff. At 6 p.m. Paper on "Some Problems in High-speed Alternators and their Solution," by Mr. J. Rosen.

Electrical Society of Glasgow.—Tuesday, February 6th. Papers on "Electric Vehicles," by Mr. C. W. Marshall, and on "The Present Inefficiency of Electrical Trading: Its Causes and Remedies," by Mr. J. B. Epsteen.

Institution of Heating and Ventilating Engineers.—Tuesday, February 6th. At the Holborn Restaurant, W.C. At 2.30 p.m. Annual general meeting; paper on "Theory of Combustion of Gaseous and Liquid Fuels," by Prof. W. E. Garner; 7 p.m., Dinner.

Roentgen Society.—Tuesday, February 6th. At the Institution of Electrical Engineers, Victoria Embankment, W.C. At 8.15 p.m. Ordinary meeting.

Royal Society of Arts.—Wednesday, February 7th. At John Street, Adelphi, W.C. At 8 p.m. Paper on "Electrical Resistance Furnaces and their Uses," by Mr. C. R. Darling.

Greenock Electrical Society.—Wednesday, February 7th. At 22, West Stewart Street. At 7.45 p.m. Paper on "The National Aspect of Electricity Supply," by Mr. F. H. Whysall.

Industrial League and Council.—Wednesday, February 7th. At Caxton Hall, S.W. At 7.30 p.m. Lecture on "Some Obligations of Industry to Labour," by Mr. F. O. Roberts, M.P.

Chief Technical Assistants' Association.—Thursday, February 8th. Discussion on "The Chlorination of Circulating Water, with special reference to the Cleaning of Condenser Tubes and Maintenance of High Vacuum," to be opened by Mr. J. R. J. Bowden.

Optical Society.—Thursday, February 8th. At the Imperial College of Science and Technology, S. Kensington. At 7.30 p.m. Annual general meeting; Presidential address by Sir Frank Dyson, F.R.S.

Chelmsford Engineering Society.—Thursday, February 8th. At the East Anglian Institute of Agriculture. At 7 p.m. Paper on "Heating and Ventilation of Engineering Workshops," by Mr. M. F. Stevens.

Royal Institution of Great Britain.—Friday, February 9th. At 21, Albemarle Street, W. At 9 p.m. Lecture on "'Rothamsted' and Agricultural Science," by Sir John Russell, F.R.S.

Junior Institution of Engineers.—Friday, February 9th. At 39, Victoria Street, S.W. At 7.30 p.m. Lecture on "The Effect of Temperature on the Properties of Engineering Materials." by Prof. F. C. Lea.

Edinburgh Electrical Society.—Friday, February 9th. At the Philosophical Institute. At 8 p.m. Paper on "Some of the Less Obvious Uses of Electricity," by Mr. W. F. Martin.

Association of Mining Electrical Engineers (Lothians Branch).—Saturday, February 10th. At Niddrie. Paper on "Pumping Plant," by Mr. W. H. McLean.

Association of Engineers-in-Charge.—Saturday, February 10th. At St Bride's Institute, Ludgate Circus, E.C. At 7.30 p.m. Social and dance.

Salford Technical and Engineering Society.—Saturday, February 10th. At the Royal Technical College. At 7 p.m. Lecture on "Radio Telephony and Broadcasting," by Mr. H. G. Bell.

Birmingham and District Electric Club.—Saturday, February 10th. At the Grand Hotel, Colmore Row. At 7 p.m. Lecture on "Advertising and Salesmanship in Relation to the Electrical Industry," by Mr. J. W. Beauchamp.

THE "ELECTRICAL REVIEW" SERVICE DEPARTMENT.

WE have to remind readers that Service Department inquiries should be accompanied by a stamped addressed envelope.

The makers or suppliers of the following devices are asked for:—

EMCO radiators.

FARNON terminals or connectors.

NOTES.

The Electrical Engineers' Ball.—This very popular and now eagerly anticipated annual event was held on Friday, January 26th, at the Hotel Cecil. The prevailing industrial depression was in no sense reflected either in the numbers or the good spirits of the guests, who totalled almost 550, a marked increase on the figures of last year.

Even this record, however, would have been considerably exceeded had not the committee acted with commendable firmness in declining to entertain the many applications which were received after a sufficient number of tickets had been disposed of to fill the available dancing space.

We do not recall a more successful evening; the orchestra was excellent (though suffering a little through being hidden in the gallery, so as to allow greater space on the dancing floor), and the refreshments and service provided by the hotel were an improvement on recent years. Generally it would be difficult at any time to find a gathering in which so many faces well known to the electrical world could be seen, and certainly at no other function is it possible to secure such clear and obvious demonstration of the fact that the eminent can and do unbend.

It may not be amiss to say that success is seldom achieved without work, and that Friday night's success was only achieved as a result of many months of hard work on the part of the Executive Committee. While we know they do not want to be thanked, we also know that they ought to be thanked, and on behalf of many who have expressed their appreciation to us, we extend our hearty congratulations to Messrs. O. H. Baldwin, W. Stanley Lonsdale, A. M. Sillar, Capt. R. J. Wallis-Jones, Messrs. J. E. Kingsbury, P. V. McMahon, C. H. Wordingham, C.B.E., and A. H. Walton.

Electrical Wholesalers' Dinner.—The dinner of the Electrical Wholesalers' Federation, Ltd., is to be held at the Trocadero Restaurant, on Thursday, March 1st.

London's Electricity Supply.—The London Electricity Joint Committee (1920), Ltd., which comprises the Brompton and Kensington, Charing Cross, West End and City, Chelsea, London Electric Supply, Metropolitan Electric, Kensington and Knightsbridge, St. James' and Pall Mall, Westminster, and Central Electric Companies, has been incorporated, with the object of formulating schemes for the improvement of electricity supply in London and the Home Counties, and is to introduce a Bill into Parliament in the next session to provide it with the necessary powers. Apparently there is an agreement between the local authorities and the company, according to which a municipal body of a similar character will be formed to centralise the generation of electricity for the supply of the local authorities' areas, whilst the company will deal with the areas now supplied by companies. The company seeks powers to purchase by agreement any generating station or main transmission line within the area, including the whole of the undertaking of the Central Electric Supply Co., Ltd., but the former owners are to manage such works for the company, and any additional supply required must be furnished at a price not greater than the cost of generation before the transfer. It is proposed to suspend the right of purchase of the companies' undertakings held by the County Council until December 31st, 1971. After January 1st, 1932, a sliding scale of dividends and prices is to be put into operation, according to which the standard dividend will be 8 per cent., which can be increased in proportion as the revenue is less than would be obtained by charging the maximum price. After providing for certain charges, the balance of revenue is to be applied to reduce the charges for the supply of electricity to the companies whose generating stations have been purchased. The company will not be authorised to supply electricity to private consumers.

A Charitable Tramcar.—An electrically-illuminated tramcar, belonging to the Birmingham Corporation Tramways Department, has completed a third week's tour of various districts in that city. Collections were taken *en route* on behalf of the Lord Mayor of Birmingham's Unemployment Distress Fund. The total sum collected to date is £3,558.

Gas and Electricity.—"Aspects of the Fuel Problem" is the subject of discussion by the Birmingham and Midland Section of the Society of Chemical Industry, and at the opening meeting at the University of Birmingham, on January 23rd, contributions on "Thermal Efficiency" were made by Dr. C. H. Lander, Deputy Director of the Fuel Research Board, and Dr. A. Parker, of the Research Department of the University of Leeds. The chairman was Mr. E. V. Evans, chief chemist of the South Metropolitan Gas Co., who stated that the gas industry had perhaps, by reason of its old age, not made that progress that was necessary. But electricity, its great rival, was probably its best friend in disguise, in fact that rivalry had led to some of the advances made in recent years. He stated that the problems of the gas industry were as numerous as ever, particularly in the sale of by-products. In the discussion following the paper, Mr. Forrest (Electricity Department, Birmingham) pointed out that electricity works could use low-grade coal and large quantities of slack; much material formerly discarded at the pit head was now being used in this way. Mr. Benton said it was obvious that both gas and electricity had a well-defined place in the country, though he thought the former was the more necessary.

Fatality.—A motor attendant received a fatal shock while at work in the Wallsend section of No. 11 pit, Lumphinnans Colliery, Fife, on January 26th. When the man was found it was noticed that one of the switch boxes was open, and it is thought that he had been working at the box when he received the shock.

Cast Iron Research.—The Monthly Circular of the British Cast Iron Research Association says that in the United States the work of the national cast-iron research body has resulted in a marked improvement of quality; considerable reduction in operating costs; the formation of the "research habit" in each plant organisation; and a tendency to do better work exhibited by all who have responsibilities in production.

Railway Electrification Justified.—Mr. Sidney Withington, electrical engineer of the New York, New Haven, and Hartford Railroad, recently contributed an article to the *Railway Review* upon the results of the electrification of the system with which he is connected. The electrification commenced with a small branch in 1907, but was gradually extended to deal with the suburban traffic and the freight and switching yard services. This last extension was completed in 1914, and since then the whole of the 88 miles of line has been electrified. The main line consists of four tracks, with the exception of 12 miles of six-track route. The single-phase, 11,000-V, 25-cycle power is generated by the company, and it is calculated that the annual saving of coal as compared with the best steam locomotive practice is 200,000 tons. The power used by the company for auxiliary services enables a saving of $100,000 to be made annually. The appreciation of electric traction by the public has been manifested in the rapid growth of suburban traffic.

Society of Technical Engineers.—A meeting of the Sheffield Branch of the Society was held on January 25th, when Mr. Norman Wyld, director, spoke of the position of the salaried "brain workers" in industry and the need for their proper organisation. He said it was the aim of the Society to remove from the conditions of service all those elements which diverted a man's mind from his work, including unemployment.

Appointments Vacant.—Draughtsman (temporary) for the City of Carlisle Electricity Department; clerk of works (£6), for the East Grinstead Urban District Council Electricity scheme; draughtsman (temporary) for the Wimbledon Corporation Electricity Department. (See our advertisement pages to-day.)

Radio-Telephony in Australia.—The Commonwealth Controller of "Wireless" states that the number of licensed amateur stations in the Commonwealth is about 800, of which only about 20 are equipped for both transmission and reception.

Active steps toward the establishment of a general broadcasting system by radio telephone are to be taken by the various companies already operating in Australia. The position in Australia has been discussed by representatives of seven of the largest manufacturers of radio apparatus, and it has been decided to approach the Federal Government, seeking the right to form a broadcasting company. The firms interested are:—New System Telephones, Radio-Communication (Pacific) Co., Western Electric Co., Australian General Electric Co., Siemens Bros., Ltd., Metropolitan-Vickers, and British General Electric Co.

Radio concerts have been broadcast recently in Melbourne very successfully and with the introduction, on December 1st, 1922, of new regulations, the registration fee was reduced from £2 to 10s., which it is expected will greatly increase the applications for permission to establish experimental stations. Large quantities of radio apparatus are being manufactured locally of excellent quality and finish; the Amalgamated Wireless (Australasia), Ltd., proposes to manufacture receivers for amateur use locally. Revised regulations for the control of radio telegraphy and telephony came into operation on December 1st. They have been devised to meet the changed position consequent upon the rapid development of privately-owned wireless stations. A feature is the precaution taken to prevent the establishment of secret stations in any part of the Commonwealth. Installations must be operated by certificated operators, and with regard to land stations the regulations stipulate that unless specially authorised by the Minister, the licensed installation shall not be utilised for the conduct of commercial traffic constituting competition with the Postmaster-General's telegraph and telephone services. The regulations provide for licences for broadcasting stations used for the purpose of disseminating news or entertainments. These installations must also be operated by certificated operators, and a stipulation is made that the stations shall not be employed for broadcasting advertising matter or commercial traffic. Further regulations relating to the control of broadcasting installations will be issued later.

The fees for the various types of licence will be as follows:—Coast station, £1; ship station, £1; land station, £1; broadcasting station, £5; experimental licence (transmitting and receiving), £1; experimental licence (receiving only), 10s.; portable station, £1; aircraft station, £1.—*Age* (Melbourne).

Pulverised Fuel in the United States.—The Lakeside generating station of the Milwaukee Electric Railway & Light Co. is the largest station that has been designed to burn powdered coal exclusively as fuel. The plant was first projected in 1916, but the war delayed operations, and the constructional work was not recommenced till January, 1920. The station is designed for an initial capacity of 40,000 kVA, and its ultimate rating will be 200,000 kVA.

According to the *Electrical World*, a rotary dumper drops the contents of the cars into a track hopper fitted with bottom shaker feeders. From the hopper belt conveyors carry the coal over a magnetic pulley, which removes any iron which is present. Then the fuel is passed through a two-roll crusher and hammer mill, from which it is discharged on to belts that carry it to the distributing belts over the green-coal bunkers in the pulverising plant. The crushers have a capacity of 150 tons of mine-run coal per hour and the belt conveyors a capacity of 250 tons per hour at a speed of 250 ft. (76 m.) a minute. When future needs require it the coal can be by-passed around the crusher and conveyed to the storage dock, where it will be handled by a bridge.

For pulverising, eight mills, with a capacity of 6 tons an hour each, are provided. The coal is delivered from them in such condition that 75 per cent. of it will pass through a 200-mesh screen and 90 per cent. through a 100-mesh screen. Each mill is provided with a fan for separating the pulverised particles that have been reduced to the desired fineness. These particles are discharged into cyclone separators, where the fuel is separated from the air and allowed to fall into a screw conveyor, which conveys the fuel to storage bins. From these it is taken by the conveying system to the fuel bins in the boiler-room.

Three driers, with a capacity of 10 tons an hour each, are provided, and will reduce the moisture content of the coal from 10 to 2 per cent. Screw conveyors carry the coal so dried to bucket conveyors, which in turn deliver it to another system of screw conveyors for transport to the dried coal bins over the pulverising mills.

The green-coal bunker into which the coal is first discharged by the belt conveyor from the unloading hopper is in the pulverising plant. It has a capacity of 3,400 tons, or slightly more than three and one-half days' supply for maximum operation of all the boilers in this section of the plant. From this bunker the coal is taken by three screw conveyors, which deliver it to automatic scales. These in turn take it to another set of screw conveyors feeding into the driers. This arrangement permits the use of any one of the three driers, and also makes it possible to check the coal accurately as it is used.

The coal is fed into the furnaces by screw conveyors from the storage bins overhead.

United States Electric Vehicle Market.—Business in the electric vehicle market during December was active. The American Express Co. has placed orders for 200 trucks, 35 of which are for use in New York, 50 in Boston, and the balance for distribution in Philadelphia, Buffalo, and other cities. When these vehicles are delivered, this company will have more than 1,450 electric trucks in service.

The Electrotaxi Corporation, which about three months ago placed a fleet of electric taxis on the streets, has purchaser two more cars; the taxis are proving extremely popular. The batteries of these taxis are charged twice daily; the cars have an operating radius of about 120 miles, with a maximum speed of 25 miles an hour. Another taxi company, which operates a fleet of gasoline-driven vehicles, is reported to be negotiating for the purchase of 200 electric taxis for use in New York City.—*Reuter's Trade Service* (New York).

A Petrol-Electric Crane.—The latest application of their petrol-electric commercial motor vehicle by Messrs. Tillings-Stevens, Ltd., of Maidstone, takes the form of a travelling crane. The crane, which is the work of Messrs. Henry J. Coles, Ltd., Derby, is mounted permanently on the chassis in such a way that the jib can be completely revolved round the vehicle in either direction. The crane is equipped with a 4-h.p. electric motor, the necessary current being supplied by an engine and generator which form the power plant of the chassis propelling mechanism, and it is adapted to lift a load of two tons at 10 ft. radius.

A Wireless Conference.—It is reported that a conference of representatives of wireless companies of Europe and America is in progress in London, the purpose of which is to bring about a combination of radio-telegraph organisations with special reference to the development of communication by telegraph and telephone with the South American Republics. The negotiators include Mr. Godfrey Isaacs and Col. A. F. H. Simpson for Great Britain; Mr. E. J. Nally for the United States; Mr. E. Girardeau for France; and Dr. Schapira for Germany.

Concessions have been obtained for wireless stations at Buenos Aires and Rio de Janeiro, and in Colombia, and national companies have been formed in the countries concerned. It is anticipated that in 14 months Rio will be in telephonic communication with Europe and the United States.

Electron Emission.—In an article published in *Science* of January 12th, by Drs. Irving Langmuir and K. H. Kingdon, of the Research Laboratory of the General Electric Co., U.S.A., particulars are given regarding the thermionic effects caused by alkali vapours in vacuum tubes. The article relates mainly to the effects of the vapour of metallic cæsium, which, like thorium, forms a film on a tungsten filament consisting of a single layer of atoms, and enables a very high electron emission to take place. Similar effects have been observed with the vapours of other alkali metals, notably rubidium. The theory of the subject is detailed in the article.

The extremely important discovery of the properties of thoriated filaments, of which particulars were published in our last issue (pp. 122 and 132), have since been given prominence in the daily Press.

The British Electrical and Allied Industries Research Association.—The half-yearly review of progress just issued by the Association shows that a classification of fibrous insulating materials, their use and requirements, has been completed, and a series of suitable test methods has also been developed. These are the basis of purchasing specifications which the Association is now drafting for materials of this group. Experiments upon the heat-resisting properties of composite insulating materials have been completed and sufficient data have been obtained to draft a specification dealing with these properties. At the same time, a provisional classification has been drawn up of the moulding properties of composite insulators, and attention given to the effects of oils upon these materials.

A full report is expected upon the whole of the investigations of porcelain; these include tests of electric strength up to 300 deg. C. and resistivity tests to 1,200 deg. C.; samples for furnace work have not yet been tested. Progress has been made upon the study of porosity by electrical methods, and upon uniformity of vitrification. For certain researches upon porcelain, the Association is co-operating with Government departments, notably with the General Post Office, in the study of surface deposits.

Work upon micanite, embracing a wide range of physical, mechanical and electrical tests, is almost complete, and a comprehensive report will shortly be issued upon this material. The study of mica has proceeded as far as the mechanical properties. Research upon insulating oils is directed towards the improvement of the electrical characteristics, to the determination of physical constants, and to the phenomena of heat transference. Sludging tests are under discussion with foreign experts, and it is believed that they may be simplified. Oil purification by the use of centrifugal separators has been most promising, and the merits and limitations of available machines for this purpose are being studied.

The electric strength of insulating oils is the subject of a detailed investigation, in which the superiority of the horizontal position for spherical test electrodes has been definitely established. It is also hoped to develop a test method not requiring the expensive high-pressure equipment now necessary. The section of the Association dealing with conductors has in preparation reports upon the heating of buried cables, and upon the mechanical properties of overhead line materials; a report already issued (dealing with wooden poles for overhead lines) has raised some important questions and will lead to an extension of the tests.

It is disturbing to learn that certain research upon electric control apparatus is held up pending the provision of the necessary facilities and funds. The value of these researches, especially to large users and suppliers of electricity, is such that a special appeal is made for support. For instance, the unique installation of test apparatus erected at the Carville power station for the investigation of switching and arcing has already given some most valuable results. The opportunity presents itself for the execution of much additional work whilst this expensive equipment is yet available.

The corrosion researches upon steam condensers, carried out in co-operation with the Institute of Metals, are proceeding actively. Research upon turbines and upon the behaviour of steam in turbines, forms another co-operative feature of the Association's activities; reports are expected upon blading and nozzles research, the latter to be published by the Institution of Mechanical Engineers.

Varnish-paper boards and tubes of synthetic resin from a variety of sources have been tested and have shown wide divergencies in quality; the more promising of these have been selected for further tests. It has been demonstrated to manufacturers that these products are capable of marked improvement, and they are giving the matter close attention. Researches concerning the thermal resistivity of dielectrics in general are unfortunately to be deferred through exhaustion of funds. The study of dielectric losses, however, has been extended to cover radio frequencies, and good progress has been made in the application of cathode-ray tubes to this investigation. Various interested technical bodies have received recommendations covering the heat-resisting properties of dielectrics, and methods of test are being developed to deal with every branch of insulating materials. A report just received shows that some quite unexpectedly important features are apparent in the relative accuracy of laboratory and workshop tests for electric strength, and these are to be further investigated.

Smoke Abatement.—After the long interval of eight years the Smoke Abatement League of Great Britain held a meeting in Manchester on January 24th. It was decided to continue to co-operate with the London Coal Smoke Abatement Society and to secure that restrictive legislation will not be modified. One member spoke in favour of technical classes for stokers, and the education of manufacturers regarding the waste of money involved by the discharge of black smoke.

Service Note.—Honorary Colonel A. Bain, T.D., M.Inst.C.E., M.I.E.E., has relinquished the appointment of Honorary Colonel of the London Signal Companies (A.T.), which he had held from July, 1912. Colonel Bain has had a distinguished service in various parts of the world, and has long been connected with the London Territorial Force Association.

Industrial Profits.—According to some interesting figures which have been compiled by the Central Council for Economic Information, the net profits made by 555 representative industrial companies engaged in production fell from £76,435,187 in 1921 to £55,274,125 in 1922. There were not decreases in all classes, and it is noteworthy that 26 electric light and power companies advanced their profits from £1,742,441 to £1,834,322, while gas profits for 32 concerns went up from £94,836 to £1,681,015, and 14 tramway companies increased their net results from £379,261 to £530,176. The largest decrease, excepting in the case of textiles, and one which is deplorable from the trade and employment standpoints, is in iron, coal, and steel; 75 companies engaged in connection therewith showing a drop from £12,631,842 to £8,781,855. Bearing the industrial slump of 1922 in mind, it is not altogether a matter for rejoicing that the net profits of 83 brewery companies leaped up from £2,091,570 to £7,806,196.

The Mangnall-Irving Thrust-Borer.—A demonstration of the Mangnall-Irving thrust-borer, described in our issue of April 21st, 1922 (p. 545), was given on January 25th and 26th at Friern Barnet, where it was required to take cables beneath a road in connection with the North Metropolitan E.S. Co.'s system. Pits were sunk on each side of the road, and after a certain amount of delay, due to the hard nature of the road in the centre, a three-inch duct was successfully cut. Further cuts were made by commencing with a small-diameter cutting head and opening them out with heads of successively larger diameters. The task was rendered difficult by the stubborn material composing the centre of the road, but even so the method was an improvement upon excavation, especially as the road bore a double tramway track. It will be remembered by readers of our description of the apparatus that the action is purely a thrust, there being no rotating motion of the cutter whatever. The power is hydraulic, and in operating through clay only a few hundredweights of pressure is necessary; for harder materials it necessarily rises, and a pressure-gauge upon the hydraulic pump indicates when it has reached the safe limit. At a sudden rise the pressure is immediately shut off and the gear withdrawn by swinging up the operating cylinder which acts upwards, pulling upon wire ropes attached to the end of the thrust bars. The latter are about three feet in length, and are screwed end to end, being fed into the cylinder as their predecessors are driven home.

The device is now being used in all parts of the country for power and telephone cable laying. It has been found that "Key" fibre conduit with long socket joints (made by the Key Engineering Co., Ltd.) is the most suitable duct to use with the apparatus, owing to its uniform exterior.

Stainless Steel.—At a meeting of the Chelmsford Engineering Society on January 18th, Mr. Harry Brearley read a paper on "Stainless Steel." The first part of the paper dealt with the causes and nature of iron rust, and the author described experiments which had been carried out in this direction. He went on to explain how, by the addition of chromium, steel was rendered proof against the action of water and other liquids, and dealt with the heat treatment which guarded against galvanic action.

The Training of the Disabled.—The Select Committee appointed to examine and report upon the systems adopted in other countries to provide for the employment of disabled ex-Service men, and to recommend a system for this country, has presented its report (H.M. Stationery Office, 3d. net). Twenty-five meetings have been held and 17 witnesses examined, reports on foreign systems have been submitted by the International Labour Office, and several members have visited France, Belgium, Germany, and Italy to study the arrangements made in those countries. Canadian and Australian schemes have also been examined. The number of disabled ex-Service men unemployed is estimated at 100,000, or 11 per cent. of their number. The number of firms upon the King's Roll in May, 1922, was 30,000, but there is a decline. The committee draws the conclusion that the voluntary system is failing, and it therefore examines compulsory schemes, but on eight counts dismisses these as impracticable in this country, although they have been instituted in other countries in Europe. It is considered that Great Britain has paid insufficient attention to the question. Without suggesting compulsion, the committee states that a body similar to that set up under the compulsory scheme in Italy should be appointed to deal with the placing of men in industry. Commenting on the present voluntary system, the committee states that it is too rigid, there is a lack of the "human touch," and an absence of incentive to joining the King's Roll. The training at Government factories has been insufficient and too short. The machinery of the King's Roll could be greatly improved by more local canvassing and stimulation of interest by decentralisation. Reorganisation of training in Government factories is urged, and the additional expenditure incurred would only absorb funds which are at present being diverted to other uses. Among other recommendations are the setting up of local voluntary bodies to administer a scheme, the provision of improverships for trainees, and the organisation of a system of after-care suitable to local conditions. The report concludes by saying that the problem is so urgent that the proposals should be carried out forthwith, and goes so far as to say that if the suggestions do not meet with success by May 1st, 1923, a modified scheme of compulsion should be instituted.

Electric Vehicles in London.—The L.C.C. has recently had under consideration applications for sanction to loans by borough councils to enable them to purchase electric vehicles for refuse collection. The largest amount for which sanction was sought was £40,830. This was required by the Hackney Borough Council to provide twenty-four electrically-propelled vehicles at £800 each, garage accommodation, charging plant, &c. It is estimated that "electrics" effect an annual saving of £1,942.

Islington Borough Council had previously received sanction to borrow £42,600 for electric vehicles, and recently it was given permission to borrow an additional sum of £1,820 for extra charging plant.

INSTITUTION NOTES.

Institution of Electrical Engineers.—ANNUAL DINNER.—We wish to remind our readers that this function will take place on Tuesday next (February 6th). Those intending to be present and who have not already applied for tickets should do so without delay, as otherwise they will run the risk of finding that the whole of the seating accommodation has been allotted.

INFORMAL MEETING.—At an informal meeting, on January 22nd, Mr. A. B. Eason occupied the chair and Mr. A. G. Warren opened a discussion on "Insulators and Insulating Materials."

Mr. Warren's remarks were mainly concerned with materials in their relation to the e.h.p. stresses, and the new radio frequencies. He stated that, except for a few recorded American opinions, there was very little written matter on the subject, and one had consequently to grope and experiment for oneself, while the problem was complicated by the small units involved. After describing verbally and with diagrams the operations of electrical leakage he asserted the need for the ideal dielectric, and appealed for research into its production.

Mr. C. C. Paterson said with regard to the data for temperature and time under test, that the Electrical Research Association had got out a tentative specification that the manufacturers and users might co-operate on and try out for results. Mr. H. M. Sayers reminded the meeting of the work of Mr. G. L. Addenbrooke on the subject, and he strongly supported the appeal for further research. He asked the meeting to imagine the enormous boon to the industry if there could be produced a dielectric with the mechanical properties of lead; or if, for instance, we could only have mica in solid lumps instead of in laminations. Mr. P. Dunsheath boldly assailed the stress hypothesis; he thought the whole point was concerned with the generation of heat, and its dissipation.

Messrs. A. C. Collins, W. S. Flight, A. Monkhouse, E. W. Moss, W. E. Rogers, A. Rosen, A. C. Warren, and Dr. E. H. Rayner also spoke.

WESTERN CENTRE.—We have received a copy of the Centre's 1922-23 handbook containing names of officers and members, the annual report for 1921-22, extracts from the Institution's Articles of Association, &c. The annual report shows an increase in membership from 421 to 507 and a satisfactory financial position. We have also received a combined programme of meetings of the South Wales Institute of Engineers and the local branches of the Institutions of Civil, Electrical, and Mechanical Engineers from January to May.

IRISH CENTRE.—At the instance of the Irish Centre of the Institution a meeting was held last week in Dublin, at which Mr. A. G. Bruty, M.I.E.E., outlined and explained the Institution's scheme for the voluntary registration of electrical contractors, at the drawing up of which he represented Ireland. It was pointed out that the scheme was a matter of distinct importance to the public as a whole, being an effort to eliminate poor electrical work. There was a fair representation at the meeting of consulting engineers, architects, electrical contractors, and others interested, and a useful discussion ensued. Mr. E. C. Handcock, M.I.E.E. (chairman of the Centre), was present.

NORTH-EASTERN CENTRE.—*Students' Section.*—A meeting of the Section was held at Armstrong College, Newcastle, on January 26th, when Mr. Rochester read a paper on "The Testing of Large Turbo Plant on Site." Mr. Kilner was in the chair. The paper was followed by a very interesting discussion. The next meeting is to be held on February 9th, when Mr. C. H. Davidson will address the students on "Electrical Machinery." The Section recently participated with the junior sections of the N.E. Coast Institution of Engineers and Shipbuilders and the North of England Institute of Mining and Mechanical Engineers in a very successful dance.

Iron and Steel Institute.—The annual meeting of the Institute is to be held at the Institution of Civil Engineers on May 10th and 11th, and the annual dinner will take place on the evening of the first day. The autumn meeting will take place in Milan, when the principal metallurgical centres and hydro-electric power stations of Italy will be visited.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* ELECTRICAL REVIEW *posted as to their movements.

MR. J. A. ROBERTSON, who has held the position of Borough Electrical Engineer of Salford during the last nine years, will relinquish his duties as from February 1st next, to devote the whole of his time to his consulting practice. Mr. Robertson is retained by the Salford Corporation as consulting engineer for the new power station and transmission system at Agecroft, and is also consulting engineer to the Preston Corporation for the new power station on the Ribble. His offices are at Brazennose House, 20, Brazennose Street, Manchester.

We read in *The Times* that the London Telephone Advisory Committee have, on the occasion of the retirement of Mr. G. F. PRESTON, the London Telephone Controller, passed the following resolution:—

"That this Committee, having heard that Mr. Preston is retiring from the controllership of the London Telephone Service, desire to place on record their sense of the able and valuable services which he has rendered to the business community in that capacity, and their appreciation of the readiness which he has shown at all times to assist the Committee in dealing with questions which have arisen between them and the Department. The Committee further desire to offer to Mr. Preston their best wishes on his retirement."

MR. HARRY HANCOCKS has been appointed manager of the London branch of the Concordia Electric Wire Co., Ltd., in place of Mr. R. W. Belcher, resigned.

The future permanent address of Mr. J. W. MEARES, formerly electrical adviser to the Government of India, is Elstowe, Jenner Road, Guildford, Surrey. Telephone No.: Guildford 782.

Lord CREWE has resigned his membership of the Governing Body of the Imperial College of Science and Technology, and Lord BUCKMASTER has been appointed to be a member until May 31st, 1925.

In the telegraph engineering department of the Post Office of the Irish Free State, Mr. P. MULLIGAN, acting engineer-in-chief, has been promoted to be engineer-in-chief; Mr. J. H. SHAW, executive engineer; and Mr. J. MCCANDLESS, and Mr. J. W. O'NEILL, assistant engineers, at headquarters, Engineering Establishment. We regret to learn that Mr. MARK ROBINSON is seriously ill.

MR. J. E. EDGECOMBE has resigned the position of director of the Electric Lamp Manufacturers' Association. MR. C. W. SULLY (of Messrs. Siemens Bros. & Co.), who has been appointed to succeed him, took up his duties yesterday.

Obituary.—The HON. R. C. PARSONS.—We regret to record the death, which took place in London, on January 26th, of the Hon. Richard Clere Parsons, elder brother of Sir Charles Parsons, F.R.S. He was the third son of the third Earl of Rosse, and was 71 years of age. He was prominently associated with engineering undertakings, was responsible for various water and drainage works in foreign countries, was connected with many engineering and other scientific institutions, and had contributed numerous papers to the proceedings of scientific societies.

MR. LEO STORMONT.—We regret to learn of the death of Mr. Leo Stormont, one of the musical directors of the Electro-Harmonic Society.

NEW COMPANIES REGISTERED.

Frank Royle, Ltd. (187,223).—Private company. Registered January 19th. Capital, £400 in £1 shares. To acquire the business of electrical and mechanical engineers carried on by F. L. Royle and G. Dane as "F. Royle & Co." in Liverpool. The permanent directors are:—F. L. Royle (chairman), "Lee Vale," Belle Vale Road, Gateacre, Liverpool; W. R. Leitch, "Rowkley," School Road, Hightown, Liverpool; G. Dane, 12, Highfield View, Stoneycroft, Liverpool. Registered office: 39, Leeds Road, Liverpool.

Yera Electrical, Ltd. (187,238).—Private company. Registered January 19th. Capital, £100 in £1 shares. To carry on the business of electrical and general engineers, manufacturers of and agents for the sale of electrical and other fittings, &c. The subscribers (each with one share) are:—Mabel England, 7, Henrietta Street, Covent Garden, W.C., clerk; L. G. Coppin, 7, Henrietta Street, Covent Garden, W.C. The subscribers are to appoint the first directors. Registered office: 104, High Holborn, W.C.1.

Coal Gas and Electrical Investment, Ltd. (187,187).—Private company. Registered January 18th. Capital, £1,000 in 950 preference shares of £1 each and 1,000 ordinary shares of 1s. each. To carry on the business as indicated by the title, that of coke manufacturers, miners, smelters, engineers, electricians, manufacturers of chemicals and manures, distillers, dye makers, and metallurgists, and that of a gasworks and electric light company. The subscribers (each with one preference share) are:—H. W. Clayton, 47, Vespan Road, W.12, clerk; C. Wybrow, 100, Denmark Road, S.E.5, clerk. The first directors are not named. Registered office: 14 and 16, Cockspur Street, S.W.

Centrifugal Clutches, Ltd. (187,240).—Private company. Registered January 20th. Capital, £1,000 in £1 shares. To acquire and deal in interests in any patents for inventions relating to centrifugal clutches and pulleys and other mechanical and electrical plant, &c. The subscribers are:—W. M. Lydall, A.M.I.E.E., 32, John William Street, Huddersfield, engineer, 200 shares; Mrs. L. A. M. Lydall, 91, Grassmere Road, Huddersfield, 50 shares; W. E. Brown, A.S.A.A., 9-11, Belsize Park Gardens, Hampstead, N.W. The first directors are not named. Secretary: W. E. Brown.

Broadcasting Installations, Ltd. (187,256).—Private company. Registered January 22nd. Capital, £1,000 in £1 shares. To carry on the business of manufacturers of, and dealers in apparatus, instruments, component parts, accessories, and things used in connection with radio-telegraphy, telegraphy through space, wireless telephony, and deep-sea soundings, &c. The provisional directors are:—W. A. Bishop, 22, Queen Anne's Gate, S.W., company director; Capt. O. Lilly, 51, Glasshouse Street, W.1. Solicitors: A. J. Greenop & Co., Bush Lane House, E.C.

Walter Bennett, Ltd. (12,527).—Private company. Registered in Edinburgh on January 20th. Capital, £2,000 in £1 shares. To carry on the business of electricians, mechanical engineers, manufacturers of motor-cars, aeroplanes, motor-boats, &c. The first directors are:—W. Bennett, "Kilmallie," Bishopton, electrical engineer; D. W. Lockhead, "Falside," Paisley, chartered accountant. Secretary: W. Bennett.

Victor Radio, Ltd. (187,278).—Private company. Registered January 22nd. Capital, £500 in £1 shares. To carry on the business of manufacturers of, and dealers in and agents for the sale of all electrical or other contrivances for receiving and/or transmitting messages, photographs, pictures, or other communications by radio or wireless, &c. The first directors are:—R. Hodgkinson, 43, Welbeck Road, Heaton, Bolton; J. R. Marsh, "St. Hilda," 1, Lathom Road, Southport; W. Hodgkinson, 49, Crosby Road, Smithills, Bolton; N. Hodgkinson, 43, Welbeck Road, Heaton, Bolton. Qualification, £50. Secretary: J. R. Marsh. Registered office: 3, Chapel Street, Salford, Manchester.

Radio Ebonite Supplies, Ltd. (187,165).—Private company. Registered January 17th. Capital, £1,500 in 1,000 10 per cent. participating preference shares of £1 each and 2,000 ordinary shares of 5s. each. To carry on the business of manufacturers of, and dealers in wireless telegraph and electrical instruments, and suppliers of raw and finished ebonite or like material to the fountain pen, tobacco pipe, or any other trade. The first directors are:—A. E. E. Lee (managing director), 4, Little College Street, E.C.4, merchant; A. L. Bushell, "Ingle Nook," Beach Avenue, Leigh-on-Sea, artist (both permanent, subject to holding £100 shares each). Registered office: 4, Little College Street, E.C.

Metropolitan Electric Wire Co., Ltd. (187,326).—Private company. Registered January 24th. Capital, £500 in £1 shares. To carry on the business of manufacturers of drawn wire, electric cabling, and lamps, and all articles made from tungsten, molybdenum, and other metals, &c. The subscribers are:—D. Sharp, 2, Gresham Buildings, Basinghall Street, E.C.2, merchant, 32 shares; A. E. Eats, 5, Auckland Road, Ilford, electrical engineer, 1 share; S. L. Forbes, 64, Mortimer Street, W., engineer, 31 shares; E. Schaap, 64, Mortimer Street, W., merchant, 31 shares; H. R. Sharp, 64, Mortimer Street, W., electrical engineer, 31 shares. The first directors are to be appointed by the subscribers. Solicitors: Kenneth, Brown, Baker, Baker, Lennox House, Norfolk Street, Strand, W.C.

N. E. S. (Bradford), Ltd. (187,303).—Private company. Registered January 23rd. Capital, £1,500 in £1 shares. To adopt an agreement with A. Wilman and to carry on the business of electrical engineers, dealers in electrical accessories, &c. The first directors are:—A. Wilman (permanent managing director), 10, Wilman Hill, Wibsey, Bradford; S. Wilman, 10, Wilman Hill, Wibsey, Bradford. Qualification: 50 shares. Remuneration of managing director, £3 per annum and 2½ per cent. of the gross turnover. Registered office: 23, Bank Street, Bradford.

Radolion Manufacturing Co., Ltd. (187,346).—Private company. Registered January 25th. Capital, £250 in £1 shares. To carry on the business of electricians, manufacturers of generators, accumulators, suppliers, and distributors of electricity and electric energy for lighting, heating, telegraphic, and telephonic communications, &c. The subscribers (each with one share) are:—A. C. S. Couldwell, 7, Queen's Road, South Norwood, S.E., wireless engineer; S. L. Forbes, 64, Mortimer Street, W., engineer; E. Schaap, 64, Mortimer Street, W., merchant; D. Sharp, 2, Gresham Buildings, Basinghall Street, E.C.2, merchant; H. B. Sharp, 64, Mortimer Street, W.1, electrical engineer. The first directors are to be appointed by the subscribers, who may appoint themselves. Solicitors: Kenneth, Brown, Baker, Baker, Lennox House, Norfolk Street, W.C.

Swansea Welders, Ltd. (187,335).—Private company. Registered January 24th. Capital, £2,500 in £1 shares. To carry on the business of welders, electric welders, boiler makers and repairers, boiler smiths and scalers, boiler and steam-pipe coverers, general engineers and contractors, &c. The permanent directors are:—H. Grove, Rose Hill Terrace, Ynistawe, Swansea, engineer; M. E. Rees, "Bath Villa," Morriston, Swansea, engineering works proprietor. Qualification, £200. Manager: H. Grove. Registered office: The Albion Yard, Morriston, Swansea.

R. W. E. Braham & Co., Ltd. (187,305).—Private company. Registered January 22nd. Capital, £600 in £1 shares. To acquire the business of a manufacturer of, and dealer in electrical and gas fittings and general metal spinners carried on by A. E. Hodgson, trading as "R. W. E. Braham & Co.," at 21, Bowling Green Lane, Clerkenwell, E.C. The first directors are:—A. E. Hodgson (managing director and secretary), 21, Bowling Green Lane, Clerkenwell, E.C.1; G. L. Adams, 21, Bowling Green Lane, Clerkenwell, E.C.1. Registered office: 21, Bowling Green Lane, Clerkenwell, E.C.1.

Cary, Hallewell & Co., Ltd. (187,260).—Private company. Registered January 22nd. Capital, £2,500 in £1 shares. To carry on the business of electrical, mechanical, and general engineers, manufacturers of, and dealers in radio and wireless instruments, &c. The permanent directors are:—A. L. Cary, 12, Crouch Road, Stonebridge Park, N.W.10; W. Hallewell, 16, Crouch Road, Stonebridge Park, N.W.10; E. L. Stacey, 44, Norfolk Road, Littlehampton, Sussex. Qualification, £50. Remuneration as fixed by the company. Registered office: New Era Engineering Works, Brentfield Road, Willesden, N.W.10.

Elkay Electrical Manufacturing Co., Ltd. (187,153).—Private company. Registered January 17th. Capital, £1,000 in £1 shares. To carry on the business of manufacturers and repairers of and dealers in all kinds of electrical goods, &c. The subscribers (each with one share) are: P. J. J. Bogelund, Regent Palace Hotel, Piccadilly, W.1, merchant; A. Schmiegelow, 4, Warneford Place, Bushey, merchant. The first directors are to be appointed by the subscribers. Registered office: 4, Southampton Row, W.C.1.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Hull Road Motor and Electrical Engineering Co., Ltd.—Mortgage debenture dated December 31st, 1922, to secure £1,500, charged on the company's undertaking and property, present and future, including uncalled capital. Holders: Branch Nominees, Ltd.

Anti-Vibration Electric Lamp Co., Ltd.—Particulars filed of £2,000 debentures authorised November 20th, 1922, charged on the company's undertaking and property, present and future; including uncalled capital, the whole amount being now issued.

Metropolitan-Vickers Electrical Co., Ltd.—Satisfaction to the extent of £205,000 on December 30th, 1922, of trust deed dated February 18th, 1902, August 31st, 1903, and August 2nd, 1904, securing £1,468,500 mortgage debenture stock.

CITY NOTES.

Stock Exchange Notices.—Dealings in the following have been specially allowed by the Committee under Rule 159:—

County of London Electric Supply Co.—75,000 six per cent. cumulative preference shares of £1 each, fully paid, Nos. 2,650,001 to 2,725,000; and 74,220 ordinary shares of £1 each, fully paid, Nos. 1,255,781 to 1,330,000.

Applications have been made to the Committee to allow the following to be officially quoted:—

Central London Railway Co.—£458,000 four and a-half per cent. redeemable debenture stock, 1942-1972.

City and South London Railway Co.—£2,750,000 four and a-half per cent. redeemable second debenture stock, 1942-1972.

London Electric Railway Co.—£3,250,000 four and a-half per cent. redeemable second debenture stock, 1942-1972.

Brisbane Electric Tramways Investment Co., Ltd.—The directors announce that they have been advised by cablegram that, in accordance with the provisions of the Brisbane Tramways Trust Act of 1922, the tramways have been acquired as from January 1st. The basis or principle upon which purchase money shall be assessed is to be determined by the Full Court of Queensland, and subject to appeal in the usual way. The purchase price, when determined, will be guaranteed by the Queensland Government. Failing a satisfactory agreement, the necessary legal steps will be taken to protect the company's interests.—*Financial Times.*

Auckland Electric Tramways Co., Ltd.—At a meeting held in London on January 25th, voluntary liquidation was resolved upon. Mr. C. G. Tegetmeier, who presided, said that the remaining assets of the company had been realised, and it was believed that after meeting all expenses and returning the preference capital, there would be sufficient left to provide a return to the ordinary shareholders of between 23s. and 24s. per share. At the confirmatory meeting Mr. E. Garcke will propose that shareholders approve of the presentation of a piece of plate to Mr. Tegetmeier.

Companies Struck off the Register.—The following companies have been struck off the register and are thereby dissolved:—

Boardman Electrical Patents Co., Ltd.
Immisch Electric Launch Co., Ltd.
Light Railways Co. of Sicily, Ltd.
London Sherardising Co., Ltd.

Tottenham District Light, Heat, and Power Co.—Dividends in respect of half-year ended December 31st at the rate of 5 per cent. per annum on preference stock, 8 per cent. per annum on "A" stock, and 6½ per cent. per annum on "B" stock, all less tax.

English Electric Co. of Canada, Ltd.—A financial contemporary states that the company has deferred its quarterly dividend, due December 31st, 1922, on the eight per cent. cumulative preference stock.

Montreal Light and Power Companies.—The Montreal Light, Heat, and Power Consolidated: Quarterly dividend of $1½ per share. Montreal Light, Heat, and Power Co.: Quarterly dividend of $2 per share.

Shawinigan Water and Power Co.—The financial papers state that a cable has been received from the company declaring a bonus of one St. Maurice Power Co. $100 share in respect of every 20 Shawinigan Water & Power Co. shares.

Greenwood & Batley, Ltd.—Interim dividend on the preference shares of 3½ per cent. and on the ordinary shares of 2½ per cent.

Westminster Electric Supply Corporation, Ltd.—Final dividend of 7s. 6d. per share, less tax, for the half-year ended December, 1922, making 12 per cent. for the year.

Adelaide Electric Supply Co., Ltd.—Final dividend of 6 per cent. on the ordinary shares, making 12 per cent. for the year.

City of Carlisle Electric Tramways Co., Ltd.—Dividend of 2½ per cent. actual for the year, carrying forward £438.

Chelsea Electricity Supply Co., Ltd.—Final dividend of 6 per cent., making 10 per cent.

Commonwealth Edison Co.—Quarterly dividend of $2 per share, less tax.

Clontarf and Hill of Howth (Co. Dublin) Tramroad Co.—Dividend at 3s. per share.

STOCKS AND SHARES.

TUESDAY EVENING

INTENSITY of business conditions has greatly moderated in Stock Exchange markets, where members are thankful to have a respite from the rush that overwhelmed them earlier in January. Nobody desires that the said respite shall last for long. Most people will be satisfied if its duration coincides with the time required to round-off the final details of the end of January settlement. Disappointment is felt with the American demands made in connection with repayment of

British war-debt to the United States. The sudden stiffening of the Turkish attitude at Lausanne, the daily slumps in franc and mark, the chaos in the Ruhr—all these tend to lay a heavy check upon bullishness. But electricity supply shares continue to forge ahead and the market is robustly strong.

The Chelsea Electricity Supply Company opened the dividend-ball in handsome style by the declaration of 10 per cent. for the year 1922, as against 6 per cent. in 1921. This was better than the greatest optimist had expected, and the price of the ordinary shares has risen 17s. 6d. to 7⅞.

Other supply shares are buoyant, in the hopes of their dividends also being substantially increased. Westminster ordinary rose 5s.; Charing Cross ordinary and Notting Hill preference are similarly better. Metropolitans gained ½, London Electrics 3/16, and other rises are apparent down the list.

The prices to which most of the electric supply shares have risen add point to the renewed hope that the directors will see their way to splitting the shares in order to render the latter more marketable. All last year, the main complaint voiced in these columns was to the effect that there were no stocks available. Three of the leading companies have already divided their capital into £1 shares, and the effect has been to broaden the market noticeably in these particular issues. Representations on this head have been raised in the past, but have met with little sympathy from boards of directors. Now, however, that prices have got to what may almost be called famine levels, the desirability of splitting the shares becomes obvious to everybody, and it need no longer be feared that the adoption of such a plan would have the effect simply of encouraging mere speculation in these investments.

Cable stocks and shares exhibit a somewhat dullish tendency. Falls occurred in Anglo-American deferred, Globes and Westerns. Great Northern Telegraphs shed £1 at 27½, but telephones are better, and United River Plate ordinary at 7, is 7s. 6d. higher, having recovered the amount deducted as the value of the rights. The price of the new shares which represent these rights has gone up to 32s. 6d. premium, which seems to be high enough at present. The demand for them, however, has been very persistent. Oriental Telephones at 2⅞ are 1/16 higher.

In order to supplement the prices of stocks and shares given in the adjoining column, it may be useful to set out existing quotations for about a score of Indian and foreign tramways in whose shares there is comparatively little market. Holders of such shares are often at a loss to know how their investments stand, and this catalogue may be of service in giving the prices now current in the market:—

Share	Nom. £	Price	Share	Nom. £	Price
Brisbane Electric ord. ...	5	5	Madras Elec. Trams. 6 p.c. pref.	5	3
Brisbane Electric Ord. 5 p.c. cum. pref.	5	4½	Para Elec. Rly. & Light ord.	1	3/9
Calcutta ord.	5	4¾	Para Elec. Rly. & Light 6 p.c. pref.	1	7/6
Calcutta 5 p.c. cum. pref.	5	3½	Pernambuco Trams. and Power ord.	1	2/9
Cape Electric Trams. ord.	1	¾	Pernambuco Trams. and Power 7 p.c. pref. ...	1	7/6
Delhi Electric ord. ...	1	10/-	Rangoon 6 p.c. cum. pref.	5	3½
Delhi Electric pref. ...	1	16/6	Shanghai Elec. Constr. ord.	10	19½
Hong Kong ord.	5s.	20/-	Utd. Elec. of Montevideo ord.	5	1¾
La Plata ord.	1	1/-			
Lisbon Electric ord. ...	1	2/6			
Lisbon Elec. 6 p.c. cum. pref.	1	5/32			

Manufacturing shares are dull in tendency. The sharp rise in Edison Swan shares which carried up the price to 4s. was succeeded by a liberal supply coming to market, with the result that the price is back to 2s. 9d., showing a rise of 3d. on the week. The first debenture stock remains at 61. India-rubber shares hardened to 13s.; Siemens are heavy, stock being obtainable at 19s. Other prices in this market show little variation, and the various cable companies' shares are unchanged.

Marconis went up to 2⅜, and the debentures to 107½, but at these prices selling occurred in consequence of the international outlook, and Marconis went back to 2 9/16 offered. The preference have, of course, been moving with the others. Canadians are a little easier at 11s. 3d., and Radios remain as quiet as ever.

Anglo-Argentine Tramways first preference dropped to 3 9/16, and Brazil Tractions at 45 ex-dividend are lower. The British stocks, however, are good, with British Electric Traction ordinary two points up at 66½, London and Suburban preference improving to 11s. 6d., and London United Tramway debenture keeping its rise at 62½. Central London ordinary assented stock is a point higher at 68. Metropolitan Consolidated at 62 and Districts at 47 are ¼ higher and ¼ lower respectively. Undergrounds are steady at their previous levels.

Engineering shares, with those of the iron, coal, steel and armament group, are keeping their prices tolerably well, but were partially affected by the general dullness that crept over the markets in the early part of this week. Rubber shares suffered with the rest, in spite of a further rise in the price of the commodity to 1s. 6¼d. per lb. While the international outlook remains so threatening, the tendency on the part of the public is, of course, to do as little Stock Exchange business as possible, and this is the reason, in a nutshell, for the greater part of the heaviness and depression noticeable in many of the markets to-day, apart from those occupied by the properous electricity supply companies.

SHARE LIST OF ELECTRICAL COMPANIES.

Home Electricity Companies.

	Dividend. 1920.	Dividend. 1921.	Price Jan. 30, 1923.	Rise or fall.	Yield p.c.
Brompton Ordinary	12	12	30/-†	—	£4 0 0
Charing Cross Ordinary	8	9	8½	+ ½	5 9 1
do. do. do. 4½ Pref.... ...	4½	4½	4⅞	—	5 7 5
Chelsea	6	6	7⅞	+ ⅛	6 11 2
City of London	14	14	2½	—	6 4 5
do. do. 6 per cent. Pref. ...	6	6	23/-	—	5 4 4
County of London	8	8	32/-	+9d.	5 0 0
do. do. 6 per cent. Pref. ...	6	6	1⅛	—	5 4 4
Edmundson's Ordinary	Nil	Nil	2½	—	Nil
do 6 per cent. Pref. ...	6/-	12/-	4½	—	6 13 4
Kensington Ordinary	9	10	8⅞	+ ½	6 0 1
London Electric	2½	4	3 1/16	+ 1/16	3 16 2
do. do. 6 per cent. Pref. ...	6	6	6⅛	—	5 17 1
Metropolitan	7	7	6⅞	+ ⅛	5 8 8
do. 4½ per cent. Pref. ...	4½	4½	4 1/16	—	5 10 9
Newcastle-on-Tyne Ordinary	8	Nil	1/16	—	Nil
do 5 per cent. Pref. ...	5	5	15/9	—	6 7 0
do 7 per cent. Pref. ...	—	7	22/-	—	6 7 3
Notting Hill, 6 per cent. Pref. ...	6	6	9½	+ ½	6 9 9
North Met. Elec., 6 per cent. Pref. ...	6	6	1 1/16	—	5 13 0
Urban Ordinary	Nil	Nil	1½	+ ⅛	Nil
do 5 per cent. Pref. ...	2½	2½	4⅛	+ ⅛	6 1 3
St. James' and Pall Mall	12	12	9½	—	6 6 4
South London	7	7	4⅞	—	5 18 0
South Metropolitan Pref.	7	7	1 7/16	—	5 18 0
Westminster Ordinary	10	10	8⅞	+ ½	5 19 5
Whitehall Elec. Inst., 7½ per cent. Pf.	—	7½	18/-	—	8 6 8

Telegraphs and Telephones.

Anglo-Am. Tel. Pref.	6	6	103½	+ ½	5 16 0
do. Def.	1½	34/6	22½	— ⅜	6 14 10
Chile Telephone	6	6	6½	—	4 16 0
Cuba Sub. Ord.	7	7	7⅞	—	9 0 8
Eastern Extension	10	10	19	—	5 5 3
Eastern Tel. Ord.	10	10	189½	—	5 5 6
Globe Tel. and T. Ord.	10	10	19	— ½	5 5 3
do. do. Pref.	6	6	11½	—	5 6 8
Great Northern Tel.	24	22	27½	—1	8 0 0
Indo-European	10	10	35½	—	7 1 0
Marconi...	25	15	2 1/16	+ 1/16	5 17 0
Oriental Telephone Ord.	12	12	2⅞	+ 1/16	*5 4 0
United R. Plate Tel.	8	8	7	+ ⅜	*5 14 4
West India and Panama	Nil	Nil	7/6	—	Nil
Western Telegraph	10	10	18⅞	— ⅛	*5 6 8

Home Rails.

Central London Ord. Assented	4	4	68	+1	5 17 8
Metropolitan	1½	2½	62	+ ½	8 12 7
do. District	Nil	1	47	— ½	2 2 7
Underground Electric Ordinary... ...	Nil	Nil	3 1/16	—	Nil
do. do. "A"	Nil	Nil	8/-	—	Nil
do. do. Income	2	4	92½	—	*4 6 5

Home and Foreign Trams, &c.

Anglo-Arg. Trams. First Pref.	5½	12½	3 1/16	— 1/16	7 14 6
do. do. 2nd Pref.	Nil	5½	3 1/16	—	8 8 6
do. do. 5 per cent. Deb. ...	5	5	82	—	6 2 0
British Electric Traction Ordinary ...	4½	—	66½	+2	6 15 4
do 6 per cent. Pref. ...	6	6	94	—	6 7 8
Brazil Tractions	Nil	Nil	45	—1½	8 17 9
British Columbia Elec. Rly. Pcc. ...	5	5	76½	—	6 7 5
do. do. Preferred ...	5	98/-	75½xd	+1	*6 4 0
do. do. Deferred ...	8	194/-	89½xd	+2½	*7 0 6
do. do. Deb.	4½	4½	77½	—	5 9 8
Lond. and Sub. Trns., 5 per cent. Pf.....	2½	3½	11/6	+6d.	6 1 9
London United Tram deb.	4	4	62½	—	6 8 0
Mexico Tram. 5 per cent. Bonds ...	Nil	Nil	78½	—	6 7 5
do. 6 per cent. Bonds ...	Nil	Nil	56½	—	Nil
Mexican Light Common...	Nil	Nil	21½	—	Nil
do. Pref.	Nil	Nil	49½	—	Nil
do. 1st Bonds.	Nil	5	67	—	7 5 2

Manufacturing Companies.

Babcock & Wilcox	15	15	3⅜	—	4 14 6
British Aluminium Ord.	10	5	18/9	—	5 9 7
British Insulated Ord.	15	15	2 7/8	—	6 9 10
Callenders	15	15	2⅝	—	6 13 4
do. 6½ Pref....	6½	6½	1⅛	—	5 15 7
Crompton Ord.	10	5	16/3	—	6 8 1
Edison-Swan	10	Nil	2/9	+3d.	Nil.
do. do. 5 per cent. Deb.	5	5	61	—	8 1 4
Electric Construction	10	10	1⅜	—	7 5 6
English Electric	8	5	16/9	—	5 19 5
do. do. Pref.	6	6	1	—	6 0 0
Gen. Elec. Pref.	6½	6½	21/9	—	5 19 6
do. Ord.	10	5	19/3	—	5 4 0
Henley	15	15	2⅜	—	6 6 4
do. 4½ Pref.	4½	4½	4⅜	—	5 2 10
India-Rubber	10	—	13/-	+6d.	—
Met.-Vickers Pref.	8	8	2 7/8	—	6 11 2
Siemens Ord.	10	10	19/-	—1/-	Nil.
Telegraph Con.	20	20	25⅞	—	*4 11 8

* Dividends paid free of Income Tax.
† New shares.

AUSTRALIA'S INDUSTRIAL PROBLEMS.

CHEAP POWER BUT DEAR LABOUR.

That Australia in the year 1921-22 became Great Britain's second best customer is a striking fact brought out in the report* of H.M. Senior Trade Commissioner in the Commonwealth (Mr. S. W. B. McGregor), to which brief reference was made in a recent issue.

Of the reasons to which Mr. McGregor attributes this circumstance, that which will probably appeal most strongly at present to the British exporter is the absence of those exchange problems that exist, not only in many foreign countries, but also in Britain's best market, namely India. Other advantages offered by the Australian market are the sentiment in favour of British goods and trading methods, a strong banking system, freedom from anxiety regarding credits, and a generous British preferential tariff.

In connection with the last-named, it must be remembered, although H.M. Trade Commissioner naturally does not find it compatible with his official position to stress the point, that the tariff is primarily intended to protect Australian manufactures and to induce the establishment of branch factories in the Commonwealth.

It is therefore interesting to examine what progress and successes or, on the other hand, what failures have occurred in this direction. Mr. McGregor points out that whilst in the cotton textile import trade the United Kingdom's position is supreme and apparently unassailable, such is not the case in machinery, engineering and allied material. There, in fact, it is weak. Britain has to face competition from local manufacturers as well as very severe rivalry from the United States, and the report adds "possibly from Germany in the near future." It is not certain, however, that on this last score there is at present much to fear. Australian sentiment is against the purchase of German manufactured goods, whilst the Commonwealth Government has shown that its Anti-dumping Act is intended to be a really effective weapon. Reverting to the subject of the competition of local manufactures, it will be recalled what difficulties have overtaken certain enterprises engaged in the metal industries, due chiefly to the excessive demands of labour for high wages and short hours. Mr. McGregor mentions the outstanding example, *viz.*, the closing of the Newcastle steel works, upon which nearly £7,000,000 has been spent, owing to high cost of wages and coal. Until matters are adjusted between employers and employés there is no encouragement, says Mr. McGregor for Australian or British interests to proceed with the industrial development of the country. There is another and rather a depressing aspect of the labour situation, *i.e.*, the Australian worker's extravagant ideas about holidays. It used to be a criticism of the business man in the United Kingdom, particularly when comparing him with certain of his Continental colleagues, that while he was spending long week-ends at golf or other sport, the latter were quietly at work improving their organisation. Apparently, in Australia, infinitely more days are lost at race meetings and other sporting events than in the old country, and it is alleged by some outspoken critics, that the clamour for increased wages in the Commonwealth would not be so insistent if less money and time were spent on gambling and drink.

Decreasing Output.

To return, however, to the Trade Commissioners report, one finds that whereas in 1913 manufacturing industries were credited with an output of £61,586,000 or approximately 28 per cent. of the whole production of the Commonwealth, in 1920-21 the respective figures were £110,028,000 or 27 per cent. If the increase of prices since 1913 is allowed for in accordance with the Commonwealth statistician's "Production Index Numbers" it is found that there was a decrease of volume of output per head of population of 16 per cent. in 1920-21 as compared with 1913.

Mr. McGregor summarises the condition of affairs which preceded the closing of the Newcastle iron and steel works, and remarks that the natural advantages of the district are great, including an almost inexhaustible supply of first quality black coal. With regard to copper, Metal Manufacturers, Ltd., a company formed by the principal producing companies in Australia (in conjunction with a British company) has considerably augmented its works at Port Kembla, New South Wales, which is now capable of handling more than the Commonwealth's requirements of copper wire, rods, bars, strips, cables, &c. It is now extending its activities to the manufacture of covered telephone cables.

The Manufacture of Electrical Machinery

Large works for the manufacture of heavy electrical machinery have been established in Sydney, the Australian company being closely associated with a well-known British concern. Another well-known British company has a large share in a switchgear factory in Melbourne.

Despite a certain progress in local manufacture, Australia offers an increasing market for electrical machinery, and in particular the electrical development of the brown coalfields of Victoria should lead to greatly increased requirements of electrical machinery, apparatus and fittings of all kinds in that State. The prospects would appear to justify British manufacturers in strengthening their Australian organisation and offering a greater degree of "service" such as their American competitors give. Imports of electrical machinery in 1921-22 were valued at £1,350,821 and in 1920-21, £1,681,713. The principal countries of origin for the latter year were:—

	£
United Kingdom	949,302
Sweden	15,548
United States	702,814
All Countries	£1,681,713

Imports of electrical switchgear and apparatus in 1921-22 were valued at £348,999 and in 1920-21 were:—

	£
United Kingdom	138,114
United States	74,200
All Countries	£215,098

Imports of electrical appliances, not elsewhere included, but including filament lamps, in 1920-21 were:—

	£
United Kingdom	382,823
Japan	70,826
Netherlands	100,502
United States	237,298
All Countries	£807,870

An ambitious project for the establishment of an insulated wire and cable factory in Australia has not materialised. Imports in 1921-22 were valued at £887,174 and in 1920-21 were:—

	£
United Kingdom	1,181,009
Japan	7,444
United States	37,183
All Countries	£1,233,091

A potent factor which should in course of time help the State of Victoria to a strong position as a manufacturer is the supply of cheap power which is being derived in increasing quantity from the Morwell brown coal deposits. Several hundred thousand horse-power could, it is said, be maintained for centuries. Hydro-electric possibilities in the Commonwealth are, however, small. Apart from the well-known Tasmanian installation, there are but two others, each involving about 50,000 kW, in Victoria and New South Wales.

Potential Consumers.

The Trade Commissioner records the decision to electrify the Melbourne cable tramway system at an estimated cost, including new rolling stock, of £4,200,000. At the time he concluded his report the conversion of the Melbourne suburban railway system was nearing completion and about 80 per cent. of the traffic was being carried by electric trains. The whole system comprises a total of 145 route miles. The expenditure to June, 1922, amounted to £5,111,000. The scheme, it will be remembered, was extended to cover the supply of power for industrial purposes. Contracts to the value of £2,400,000 were allotted to British manufacturers, by whom most of the plant was supplied except the train equipments and a small portion of the sub-station converting plant, switchgear and overhead wiring which was obtained from America during the war, and the condensing plant, which was made in Australia.

Trade Bureau.

The Commonwealth Government possesses an important organisation to deal with commercial and industrial affairs. Its Bureau of Commerce and Industry which has been incorporated with the Commonwealth Board of Trade, is designed to foster and develop primary and secondary production in Australia, notably the encouragement of branch factories of British manufacturers. The Board acts as a Key Industries Committee for the purpose of investigating and making recommendations concerning those necessary basic industries which, from a national point of view, should be established and encouraged in the country. The Government has appointed a Tariff Board consisting of a representative of the Customs Department and two business men representing respectively, importers and Australian manufacturers' interests. The Board has to advise on all questions relating to import duties, bounties on manufacture, &c.

* Report on the Economic and Financial Situation of Australia—Department of Overseas Trade, 2s. 6d.

THE PHYSICAL SOCIETY OF LONDON.

EXHIBITION OF SCIENTIFIC INSTRUMENTS.

(*Continued from page* 151.)

Nalder Bros. & Thompson, Ltd.

Amongst the large display of well-known instruments on this firm's stand a prominent place was given to a complete series of new and improved alternating-current instruments, including deflectional frequency meters, rotary synchroscopes and power factor meters.

The principle on which the "Nalder-Lipman" deflectional frequency meter works is that for a resonant or nearly resonant circuit there is a rapid change in the power factor of the current flowing through it for comparatively small changes of frequency, and accordingly, if one of the circuits of a phase-meter be tuned to resonance for a selected or normal frequency, any departure from that frequency will be measured by the movable element of the indicator.

It is claimed that the degree of accuracy obtainable on this type of frequency meter is very high, and the slightest change in frequency is instantaneously indicated by the pointer. No moving coils are employed, and all extraneous controlling forces due to conducting ligaments or brushes are thus entirely eliminated.

The instrument is independent of temperature errors. A variation of voltage of plus or minus 30 per cent. from the normal for which the instrument is designed does not affect the readings as much as 1 per cent. For pressures above 200 volts or for frequencies above 100 cycles per second even a greater degree of accuracy can be obtained. Within the range of wave distortion found in commercial practice no appreciable error is caused thereby. The instrument is very dead beat. The accuracy of the instrument is in general well within the limits allowed by B.E.S.A. Specification No. 89.

One of the most striking features of this instrument is the very open and long scale (see fig. 15). For switchboard use this frequency meter can be supplied either in the round or sector pattern.

A new type of rotary synchroscope was also shown. No moving coils are employed, it is self-contained for pressures up to 650 V, and the power consumption is only from 7 to 10 VA per side, thus necessitating only a small potential transformer. One instrument exhibited was a "type A" with an 8-in. dial, consisting essentially of two parts—the field coils, connected to the busbar terminals of the meter, thus receiving energy in step with the busbar e.m.f., and the magnetising coils, connected through a phase-splitting device to the incomer terminals of the meter, thus receiving energy in step with the e.m.f. of the incoming machine. The moving system comprises a spindle having two co-axial magnetic elements separated by non-magnetic material, the two quadrant vanes of each element being set at 180 deg. to each other, and the axis of symmetry of each pair being at 90 geometrical deg. to that of the other pair.

The combined electromagnetic force (or torque due to the interaction between the magnetic fluxes of the two combinations of fixed pressure coils) causes the moving-iron system, and with it the pointer, to revolve in one direction or the other according as the frequency of the incoming machine is greater or less than the busbar frequency. Moreover, the number of revolutions per second made by the pointer is exactly equal to the difference in cycles per second between the incoming and the busbar frequencies. For example, with a frequency of 50 cycles per second on the busbars, and of 51 or 49 on the incoming machine, the pointer would revolve once per second clock-wise or counter clock-wise respectively. Hence, when the incomer is running at synchronous speed the pointer is at rest, but its position on the dial indicates at once the phase relation between the busbar e.m.f. and that of the incoming machine. The speed of the incomer is adjusted until the pointer moves round slowly to the vertical mark on the dial, when the paralleling switch may be closed. Since one-half revolution, or about 10 in. of scale for an 8-in. dial instrument, corresponds to 180 electrical deg. phase displacement, it will be realised with what a high degree of precision synchronising may be accomplished with the N.C.S. synchroniser.

It may be wished to employ a synchronising lamp in conjunction with the instrument. The lamp is then placed on the top of the meter, and the voltage across its terminals varies from zero to twice its normal voltage during the time the incomer goes through a complete cycle relatively to the busbar frequency. If transformers are employed, by making suitable connections, the lamp can be arranged to be either "bright" or "dark" at synchronism, but if no transformers are used the only possible arrangement is for the lamp to be "dark."

When the instrument is some distance from the operator, the position of the pointer may not be sufficiently distinct to ensure correct synchronising. This difficulty is overcome by using "type C," fig. 16, a feature of which is that a signalling arrangement is provided in the centre of the instrument, whereby a movable circular spot of light will appear red, green, or white according to the position of the pointer round the dial. This arrangement enables the engineer at the stop valve to receive a definite indication as to the speed of the incoming machine, and he therefore knows whether to increase or decrease the speed of his engine. Moreover, the coloured spot of light and the pointer are always in line with one another, and consequently the position of the light spot indicates the phase angle between the incomer and the busbars, a red light being shown when out of phase, a green light when nearly in phase, and a white flash light at the correct moment for closing the switch. The speed of the incomer is adjusted until the coloured spot of light, and with it the pointer, moves round slowly to the vertical mark on the dial, when the paralleling switch may be closed. Two small lamps, which are easily replaced, inside the instrument provide the necessary illumination internally for the coloured signalling attachment. A new development of power-factor meter gives complete freedom of rotation and a 360-deg. scale (see fig. 17). There are no ligaments or moving coils, the instruments indicate accurately on small loads, and are supplied for use on single or polyphase (balanced and unbalanced load) systems. The meters are constructed on the "component field" principle, according to which the production of a "resultant rotating magnetic field" is, it is claimed, avoided by arranging the field (current) coils with their axes parallel in different planes, the moving system comprising a spindle (made up of non-magnetic and magnetic portions, the latter being magnetised by individual pressure coils) and an appropriate number of thin iron vanes mounted thereon in these parallel planes. In the case of single-, two- and three-phase balanced load instruments in which current is taken from one phase only, and pressure from one, two, or three phases respectively, only one large "field" current coil (wound in two sections) is employed. It should be particularly noted that in all cases the moving-iron system is magnetised by pressure coils, thus ensuring great accuracy for widely-varying loads. The indications are independent of variations of current, pressure, or temperature, and are unaffected over a wide range of frequency and wave form. In some cases a saving in the number of transformers required to operate the instrument may be effected.

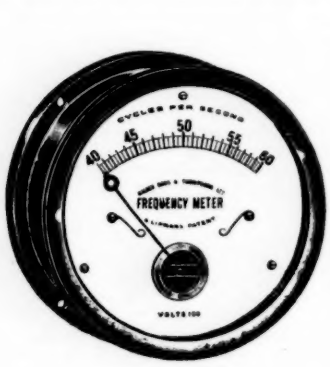


Fig. 15.—Deflectional Frequency Meter.

Fig. 16.—A New Rotary Synchroscope.

Fig. 17.—Power Factor Meter.

H. W. Sullivan, Ltd.

This display was divided into several sections. Amongst the high-frequency a.c. measuring apparatus for various determinations at telephonic frequencies were a thermionic valve oscillator for generating a.c. at frequencies from 400 to 2,000 cycles; a screened and balanced transformer, through which the supply passes before application across the alternating-current bridge arrangements; non-reactive ratio arms, rheostats, and slide wires, in which the residual self-inductance has been reduced, it is claimed, to limits hitherto considered impracticable.

The cable telegraph testing and signalling apparatus included K. C. Cox's selenium magnifier for submarine cable working. A sectional selenium cell is acted upon by the light beam from the receiving galvanometer, the selenium sections being arranged as a series of bridge arms, and the galvanometer deflections, *i.e.*, the received signals, cause large corresponding current changes in the selenium bridge circuit, in which circuit is placed the local receiving instrument or relay.

Amongst apparatus for the determination of effective resistance, inductance, and capacity at radio frequencies, of condensers, inductances, aerial systems, and other radio-frequency circuits, was a screened radio-frequency Wheatstone bridge, fitted with vacuum thermo galvanometer. (The resistances of the ratios and rheostat arms are truly non-reactive, as they have no measurable inductance or capacity.) Radio-telephony transmitters and receiving sets for experimental and broadcasting reception; wavemeters and heterodynes of 150/20,000 metres, and 150/4,000-metres wave-length ranges; and a standard wavemeter (40 to 25,000 metres), as designed by and built in conjunction with the National Physical Laboratory (Dr. D. W. Dye) for the Government of the Dominion of Canada. This consists of a group of precision standard apparatus for laboratory measurements of wave-lengths. Two variable air condensers are employed, one of 300 micro-microfarads, and the other of 3,000 micro-microfarads maximum capacity, and both have insulation of silica quartz. A series of 13 standard inductances wound with Litzendraht wire are used together with fixed condensers to cover the required range of wave-lengths. Two alternative detecting arrangements are provided; a vacuum thermo-junction and heater in conjunction with a galvanometer or a crystal rectifier in conjunction with an inducing turn.

A standard variable air condenser, for accurate adjustments, was shown, having been specially designed with a view to very accurate setting, and a scale diameter of approximately 45 cm. is employed. It has a large screening case and a distant-control operating shaft working through a micrometer adjustment gearing. Silica quartz is used throughout for the insulating separation between fixed and moving plate systems.

F. Harrison Glew.

This exhibit of radium apparatus for medical and demonstration purposes is an annual feature of the show. A new series of lantern slides for lectures on radio-activity was to be seen; also ionised cloud apparatus consisting of two similar glass tubes connected to the same compressor. When the pressure is suddenly released a much denser cloud appears in the tube containing ions, produced by radium within the tube; the amount of vapour precipitated is the same in each tube, but the particles are more numerous in the ionised gas. The two tubes are side by side, making comparison for effective lecture experiment easy.

Gambrell Bros., Ltd.

Messrs. Gambrell Bros., Ltd., divided their stand into three sections—namely, "Efficiency" radio apparatus: inductances and holders, tuners, amplifiers, complete receiving equipment, and component parts for experimental work. Pyrometry: Portable and wall-type temperature indicators. Apparatus for general testing: Resistance boxes and bridges, potentiometers, galvanometers and accessories, keys and plugs, condensers, voltmeters and ammeters.

Dubilier Condenser Co. (1921), Ltd.

The Dubilier Condenser Co. (1921), Ltd., drew special attention to the following condensers amongst its numerous exhibits: Type "C.P." in aluminium cases, with special insulators, for high-frequency work and capable of carrying up to 50 amps. Type "577" suitable for working continuously at 1,000 V, and carrying one amp. of high frequency current (capacities ranging from 0.00001 to 0.01 mfd.), the capacity being claimed to be absolutely constant. There were also shown an absolute standard of capacity that is guaranteed to have an error not exceeding 0.1 per cent., a c.w. radio insulator which is "guaranteed for ever," and condensers for protecting overhead transmission lines at pressures up to 110,000 V.

Igranic Electric Co., Ltd.

The Igranic Electric Co., Ltd., had on view various "honeycomb" and cross-wound slab inductance coils and cotton interweave coils; an intervalve transformer with spring clip terminals; a machine for automatically winding two coils simultaneously and inserting paper between each layer of wire; and a remotely electrically-controlled (steam or water) Hopkinson valve which incorporates a lost-motion device that permits the driving motor to attain full speed before becoming connected to the valve so that it imparts a hammer blow for unseating it.

(*To be continued.*)

THE POSSIBILITIES OF UNDERGROUND TRANSMISSION AT 100/150 KV.

Discussion at Newcastle-upon-Tyne.

At a meeting of the North-Eastern Centre of the Institution of Electrical Engineers, on December 11th (Mr. F. G. C. Baldwin in the chair), Major A. M. Taylor submitted his paper upon the above subject, which was abstracted in our issue of December 15th, 1922.

Mr. H. W. Clothier opened the discussion, and speaking as a switchgear manufacturer, said the suggested application of the "armour-clad" principle to cables was specially interesting. As a general principle that system had many advantages—safety to life, avoidance of interference by weather, protection from lightning, and simplicity in maintenance. He had been told by an engineer that in long transmission work in India an ordinary cable system would be probably cheaper than an overhead line, because of the cost of patrolling it &c. He thought the number of transformers required for the scheme might be good for the makers, but represented a large expenditure. The switching operations, also, seemed to him to be very numerous.

Mr. J. Schuil pleaded for the simplification of the scheme, and asked if no economic use could be made of the balancing of the inductances.

Mr. R. J. H. Beatty did not think there was an excessive complexity in the scheme, having regard to its character. The number of transformers might be reduced, but it was doubtful whether such a reduction was desirable.

Mr. E. V. Twiss said that as one interested in overhead lines, nothing would please him better than to see cables able to stand as high voltages as were possible in the case of overhead lines. It would greatly facilitate the bringing of high voltages into large cities, and also facilitate the crossing of railways, of Post Office trunk lines, &c., and therefore be very helpful in many ways. He had consequently welcomed the paper with thankfulness and expectancy, hoping that the author would show them the way to attain that object. The scheme was based on 33,000 volts, as compared with 50,000 volts over 30 miles, but 50,000 was an economic figure. The author's figure for an ordinary three-phase cable was about £1,000,000, and by substituting the author's scheme they would reduce that to about £500,000, but an overload line for 100,000 volts would cost about £100,000 for a single tower line, and a double tower line would cost probably about £150,000. Further, in going 30 miles they must traverse open country, which was not in favour of the underground cable. The alternative would be to take the cable by such roads as there were, but such a detour would add to the cost.

Major A. M. Taylor, in his reply, pointed out that it was proposed to bring the cables along the railways, which would meet some of the last speaker's objections, avoid trouble in obtaining wayleaves, and lessen the cost.

Discussion at Glasgow.

The paper was read at the Scottish Centre of the Institution on December 12th, and in opening the discussion Mr. A. E. McColl said that from the apparent cost it did not seem as if the transmission of 50,000 kW over a distance of 30 miles was a practical proposal; engineers would not consider the expenditure of one million pounds in transmitting electricity that distance, and it was possible that the building of a station on the site would be a cheaper proposition.

Prof. G. W. O. Howe found the paper anything but easy to digest, and even with the benefit of Mr. Taylor's exposition, he would not care to pass an examination on the hexagons. The fundamental idea was a very sound one, as the weak point of high-voltage cables was the fact that the inner layers were stressed very much more than the outer layers.

Mr. A. F. Stevenson asked if anybody could tell them of a cable which had broken down due to being too highly stressed. It would be an economy to do away with the hempen core altogether. If he had a 100,000-volt cable job he would be rather inclined to do it with six single rather than with two triple-concentric cables.

Mr. D. Berry said, with regard to the single cable with a hempen core, that should a fault develop and moisture get

in, "it would be good-bye to this cable." There had been some trouble over the French cables, attributed to mechanical damage. Their experience at a voltage of 20,000 with single cables had been that mechanical damage was not an unlikely thing; the cable was so flexible that it was easily knocked about and sufficient care was not always exercised in the bending—one objection to the use of single cables. For voltages below 50,000 he did not suppose that methods other than those adopted at present were required; he understood that a 50,000-volt, 3-core cable had been laid and was operating successfully.

Mr. A. P. Robertson pointed out, with regard to the author's fig. 13, showing the method of finishing off the end of a cable so as to reduce the potential gradients at the approach to a joint which was to be performed at the makers' works, that it was not always possible to know exactly the length of a cable and where the joint was going to come; it looked rather a complicated joint. His fig. 11 was a fearsome diagram. There were thirty miles between the different sets of connections and, apart from the cost of transformers and the space taken up, the risk of making a wrong connection seemed to be very great, and if tappings were taken to substations the system would be very complicated.

Mr. C. W. Marshall was of the opinion that the actual power transmission should have been thoroughly discussed before dielectric stresses were touched on at all. It might be quite obvious to the author that the 6-phase system he advocated was workable, but he had been unable to convince the speaker that it was so either in the printed matter or in his exposition of it at Glasgow. If, however, it was granted that the system of power transmission was practicable, the objection that the protection of the system would be almost impossible would not hold, as this could readily be done on the low-pressure side of the step-up transformers. The paper had been "served up" in a form which was wholly unintelligible to the majority of the readers.

Major A. M. Taylor, in reply, explained that the actual cost of the installation only was of the order of £0.25 per kVA per mile, and hitherto authorities on the subject had been talking quite glibly of £0.3 and £0.4 per mile, and hoping eventually to reach £0.2 or £0.25. A case of overhead transmission in the United States of considerable importance worked out at something of the order of £0.2 per kVA per mile. As to the voltage on the lead sheath, he proposed to solidly bond the lead sheaths together, so that they would be solidly earthed along the whole length. None of the cable makers appeared to be scared about making the joints.

The French cable trouble was that the cables were too small in diameter, and therefore the bending caused trouble. The capacity current was not uniform along the line, but if the line was used for railway traction, there would be railway sub-stations every ten miles or so and, in addition, combined schemes for public supply; therefore, there would be practically uniform distribution.

Discussion at Birmingham.

The paper was read at the South Midland Centre of the Institution on December 13th.

An interesting discussion was commenced by Mr. W. Forrest, who said that the estimates of possible saving to be effected by the adoption of the author's system, as against the use of ordinary three-core, 30,000-volt cables were so great that one wondered whether the estimates were based upon really reliable manufacturing costs. As far as he was aware no cables of the type proposed by the author had been actually made, and until the system had been tried many people would regard the estimates of cost with a good deal of scepticism. The superiority of 25 periods over 50 periods for long-distance transmission had not been dealt with by the author. What would the reduction in the losses amount to if the lower frequency was used? When very high potentials and long-distance transmission lines were considered, especially when underground cables were used, the superiority of low frequency became very marked, and from the point of view of dielectric and sheath losses it should be possible to produce a cheaper and more reliable cable for 25-period than for 50-period working.

Mr. R. H. Rawll drew attention to the formula :—$i_d = 2\pi f c e / \sin \theta_d$ which appeared in the author's preliminary remarks; e was stated as the "voltage between core and intersheath." As a concentric ring of insulation was being considered, of which the capacity per foot length c had already been calculated in a previous formula, and since i_d was the capacity current flowing radially through this ring, e must be the potential difference across this ring, and not as above stated. For example, the voltage absorbed by the tenth layer of insulation was (from Table I, Appendix C) 1,840, which was obviously the value of e to be used in the formula in question. If, however, e was taken as defined above, this value would be 41,250 volts, being the voltage between the core and this layer—a very different thing indeed. That the author did not mean the latter figure to be taken was very obvious from a perusal of the calculations given.

Mr. G. Rogers thought the advantages claimed for the new method of transmission were of such an order that the scheme called for the most careful attention. If the saving in capital cost of the new scheme, as compared with the normal three-phase transmission at 30,000 volts by means of three-core cables, was only half that claimed by the author, then it seemed to him a strong case had been made out. The connecting up of the transformers and switchgear, both at the sending and receiving ends, would appear to be rather complex and difficult. How did the author propose to dispose of the inner lead sheath at the ends of the cable? It would appear that the usual methods of cable protection would not apply, and special arrangements would have to be devised.

Mr. W. J. Line said that in the right-hand portion of fig. 8 Major Taylor proposed to superimpose on the two six-phase systems, which were linked together and represented by the two hexagons, a 120,000-volt, single-phase supply. In fig. 10 *et seq.* it was similarly proposed to superimpose a three-phase supply at increased voltage (represented by the "major star" in the figure) on the three interlinked six-phase systems represented by the three hexagons, and thereby transmit increased power. How did that affect the current-carrying capacity of the cables in the separate hexagons? It appeared that the proposal must involve more current in the lines. Did not that mean increasing their size? Towards the end of Section V the author pointed out that at light loads the charging current in the line due to its capacity would be reduced to about one-third of its maximum. The author proposed also to offset the charging or leading current by the magnetising or lagging current of an induction motor or transformer load, and thus reduce or eliminate the wattless current to be supplied by the station. But at times of light load, unless the reduction took place through the actual shutting down of motors, the lagging or magnetising current of the motor load would not fall off in the same way as the leading or charging current of the line.

Mr. W. Lawson thought the paper undoubtedly of outstanding merit. At first approach the author's scheme owing to the exhaustive treatment of the details, appeared unusually complicated, but this impression largely disappeared with a fuller grasp of the scheme as a whole. In separating the phases, and in the particular method of employing intersheaths for the better distribution of dielectric stresses in the insulation, the author had succeeded in designing his cables without introducing any condition of working which was not already met with in e.h.p. transmission cables. The really novel and debatable feature of the scheme was the author's arrangement of the transformers. Here some complication crept in with the necessity of having to employ a large number of transformers of various primary and secondary voltages, but providing there was no serious disadvantage in this (and such was not self-evident) the objection to the scheme on the score of complexity was discounted. Since the discussion the author had informed the speaker that he proposed to discard the superposing transformers, while still transmitting power at 100,000 volts through the central cores. With this modification the scheme would take the form of a triple six-phase transformer scheme. Did the author consider the difficulty of jointing single-core cables having a hempen centre more serious than the jointing of his own cables? A valuable feature of the scheme consisted in its being able to take up loads of poor power factor with gain in efficiency and regulation. However, the figure of 0.7 which the author assumed as the probable average power-factor of the substation load was too low, in view of the attention which was now being given to the improvement of consumers' power-factors. In the comparative costs of 30,000-volt, and 100,000-volt schemes detailed in appendix (E), the costs of trunk cables for the former included laying, excavating, and reinstating streets, but apparently the cost of this work had not been included in the amount given for cables in respect of the 100,000-volt scheme.

Australian Trade.—From particulars furnished to the Department of Overseas Trade by H.M. Senior Trade Commissioner in Australia (Mr. S. W. P. McGregor), it appears that the import trade value figures for the quarter ended September last show that for the first time during and since the war the United Kingdom has practically recovered her pre-war position as regards imports into Australia. The changes, compared with the previous quarter as regards imports from the United Kingdom were an increase of textiles from £5,591,474 to £7,191,588, an increase in metal manufactures (other than machinery) from £2,311,018 to £2,859,304 and a decrease in "miscellaneous" from £2,808,865 to £390,505. The principal changes in imports of United States origin during the two quarters referred to include an increase in machines and machinery from £806,103 to £1,032,763 and an increase in metals and metal manufactures from £1,026,079 to £1,391,561.

Short-wave Radio-Telephony.—With the object of encouraging the study of short wave-lengths by amateurs, French manufacturers are offering several important prizes to those obtaining the best results in receiving or transmission in the Trans-Atlantic trials.

RAILLESS TROLLEY TRACTION.

By C. W. G. TAFFS, A.C.G.I., B.Sc.

(*Abstract of paper read before the* Institution of Automobile Engineers.)

Regarding the relative merits of the tramway and the motor omnibus for urban and inter-urban communication, two broad considerations, which must be satisfied simultaneously, govern any attempt to decide that issue. They are finance and utility, and it is on those considerations that the claim of railless trolley traction to be a panacea for the difficulties now faced by many public authorities may be advanced. Many of our more important provincial municipalities have adopted the system either as extensions of, or superseding, tramway and motor omnibus routes, and statistics for such undertakings demonstrate that from the point of view of financial advantage alone, the claims of the trolley-bus are adequately justified.

Utility involves capability of manœuvring, reliability, and (in a certain degree) maintenance costs. For general utility, the railless electric vehicle satisfies the second condition necessary for a successful local transport undertaking.

The choice between alternative methods of transport depends for success on the proper compromise between the two leading factors of low first cost and low working expenses. An equitable comparison of the economies of the different systems of road transport, will be to take commonly accepted figures for material, rolling stock, power and wages and to derive hypothetical "trading accounts."

Assuming a housing project involves the construction of 600 houses on a site three miles from the centre of a town, the population will be 3,000, of whom about 750 workers will require travelling accommodation in the same direction within a period of 45 minutes, morning and evening. Tramcars and trolley-buses both require overhead lines and feeders; for the trolley-bus the overhead equipment is necessarily more expensive, as positive and negative trolley-wires have to be provided costing, say, £10,000 and £12,000 respectively. The tramway will require three miles of double track costing, say, £75,000, and for car-shed and repair shop buildings, assume in each case £6,000, and for the equipment £2,000, £4,000 and £3,000 respectively for the tramway, petrol omnibus, and trolley-bus. A tramcar costs about £2,000, a petrol omnibus about £1,750, and a trolley-bus about £2,000. The last will eventually be produced more cheaply than the petrol 'bus, since at present it is not being manufactured on a mass-production scale.

The total capital outlay and annual standing charges for interest and depreciation are summarised in Table I, allowing varying rates of depreciation for the different items.

Table I.

	Capital outlay. £	Standing charges. £
Tramway	113,000 ...	11,605
Motor omnibus	38,000 ...	6,890
Trolley-bus	53,000 ...	6,430

Regarding the probable traffic density over such a line and assuming a total car mileage of 4,620 per week of seven days, petrol at 2s. a gallon, the wages of driver and conductor at 3s. 6d. per hour, electricity at 2d. per kWh, and allowing £2,000 per annum as the cost of management, supervision, &c., the total working costs would be as set out in Table II:—

Table II.

	Pence per car-mile.	£ per annum.
Tramway	11.6 ...	10,137
Motor omnibus	16.0 ...	16,000
Trolley-bus	12.0 ...	12,000

The combination of these two tables shows that the economic revenue per annum from the tramway system would require to be £21,742, from the motor omnibus £22,890, and from the trolley-'bus £18,430. Differentiating between workers' fares and ordinary passengers' fares, the economic fare would require to be for the tramway 1.72d. per passenger mile, for the motor omnibus 1.84d., and for the trolley-'bus 1.37d.; the fare for the tramway thus being 25 per cent., and for the motor omnibus 35 per cent. higher than that for the trolley-'bus. However, when the conditions were such as to demand very large cars, a tramway would become necessary, and when the traffic was very light and infrequent, motor omnibuses would be economically justifiable. The total working expenses of the three systems in pence per car-mile would be for the tramway 16.92, the motor omnibus 20.17, and the trolley-'bus 13.17.

From every consideration the electric motor as a propulsive agent is without a serious competitor. Why, then, should it not maintain its superiority when applied to railless traction? The foregoing observations gain force when the conditions under which electricity has been applied to railways are considered. The restriction of steam trains to long journeys, and employment of electric trains on short, intermittent, runs is an economic compromise between the relatively great expense of the steam locomotive and the interest on the capital expenditure on long-distance electric traction. The conclusion is that as the conditions of service approach those for which road transport is suitable, the tendency is to employ electricity. Owing to its simplicity and the ample strength and capacity for the work assigned to the motor, there is small likelihood of breakdown in the machine, while its wearing parts are few and easily renewable, the armature bearings and the commutator bars have practically an indefinite life, and the successful introduction of commutation poles in order to gain sparkless operation has reduced the risk of fire to a negligible quantity.

The essential quality in the power unit for a satisfactory intermittent service is the ability to accelerate rapidly. The series electric motor is able to apply its largest torque at zero and low speeds to a remarkable degree.

The speed control with a single-motor equipment by a simple controller (which passes the current through a rheostat for starting purposes, then as the speed increases the rheostat is gradually cut out of the circuit until the handle reaches the full-power position), although simple, is uneconomical, for a large proportion of the line current is frittered away as heat in the rheostat during the accelerating period.

The series-parallel system of control gives a pair of motors this property of large starting torque to a still greater degree, and apart, therefore, from the advantage of the economy of power at starting, the series-parallel system allows smaller rheostats to be employed, and in addition allows of economical running at two speeds. The complete operation from start to full speed is all performed in one controller. On certain railways as many as three motors are arranged in this way, with still more advantageous results. A further point in favour of twin-motor propulsion is that in the event of failure of one of the units it can be cut out of action at the controller.

The economical manner in which the electric motor utilises the energy received from the power station is not the least important point on which it shows to advantage. The motor is able to develop at starting or on inclines a torque far in excess of that required for normal running by a call on the reserve of power available at the station. The reverse of this also exists, and gives a distinct advantage over the petrol engine, which has to be kept running at a comparatively high speed, even when the vehicle is coasting down a slope. The economy of the electric motor is also operative between the two extreme cases of maximum and zero torque, and under certain conditions the economy is effected automatically; for example, when running on an undulating road, the changes of grade on which require no manipulation of the controller. From the standpoint of running economy of power the advantage would appear to rest with the electric motor.

The only use made of the motor as a brake at present is in case of emergency. Positive braking by this means is a great asset and is common to all electrically-propelled vehicles. Mechanical band-brakes which operate on drums on each rear wheel and on the motor armature shaft, are found sufficient for all service requirements.

The essential condition of mobility presented a problem of great difficulty in the case of the trolley-'bus. An over-running trolley (a carriage mounted on four grooved wheels, one pair running on each wire) gives perfect mobility, but has its drawbacks, for it is difficult to adapt it to any of the recognised types of overhead crossing, so that the use of the trolley-'bus in conjunction with an existing tramway system is rendered impossible. In spite of the objections, the over-running trolley is largely used, principally on the Continent, where the Mercédès-Stoll type of collector is in vogue.

A suitably-designed trolley equipment of the ordinary tramcar type will, however, permit contact with both wires at moderate speeds, and deviations up to 10 ft. from the centre-line of the overhead system. To obtain greater deviation and at the same time to allow of high speeds, an equipment is required which will operate with poles at right angles to the car and give only a low upward pressure on the wires. For example, with 20-ft. poles the reach-out with a design of equipment of this kind would be about 17 ft. from the centre, and would confer freedom of manœuvre on the vehicle anywhere on a road 40 ft. wide. Up to the present freedom to this extent has not been demanded, but with the adoption of the system in the main streets of our larger cities, a development in this direction will become essential.

The best modern British practice, which overcomes the risk of the trolley wheel coming off the wire with a deviation of at least 15 ft., depending on the length of the pole, and the vehicle running at full speed, which at the same time possesses none of the disadvantages previously referred to, is to use a balanced under-running trolley. Briefly, its successful application is due to a judicious selection of the upward pressure of the trolley-wheel on the overhead wires, which is lower than in tramway practice, and the use of springs operating in a horizontal plane. The latter control the moving part of the trolley-base and prevent excessive side pressure of the trolley-wheels on the wires. The cars running with this system of current-collection in Britain are provided with two booms, each of which is capable of separate deviation. The use of a single boom carrying a branched trolley-head, controlled by one base, has been successfully tried in Shanghai. The cars originally supplied to that city were provided with the double-boom equipment, which has since been superseded. With some such form of flexible current-collecting arrangement the trolley-'bus is free to manœuvre anywhere on a road, is capable of overtaking and being passed by other vehicles, and possesses all the advantages that the petrol-driven rail-free vehicle has over the rail-bound tramcar.

Another aspect is that in spite of its flexibility of manœuvre on any road, the trolley-'bus is bound to its route in the same way as the tramcar, because its supply of energy is derived from an overhead line, and it is therefore at a disadvantage when compared with a petrol-'bus. It will be admitted that although the latter is as free as a pleasure car to run along any road, yet the elementary conditions of service to the travelling public are such as to compel the petrol-'bus to adhere to defined routes and time-tables in precisely the same manner as a railway or tramway. The limitation of being route-bound that applies to a trolley-'bus for physical reasons is therefore equally applicable to a vehicle with a self-contained motive power for reasons of service.

The capability of the trolley-'bus to manœuvre anywhere on a road 30 ft. wide shows that these vehicles share equally with the petrol-'bus a great advantage over the tramcar, and there is also the further advantage, both in comfort and safety, in being able to draw up to the pavement to take up and set down passengers.

It is also necessary to take into consideration the ease with which such a high-powered and flexible vehicle can negotiate narrow, steep, and tortuous streets. The author lately received a letter from the chief engineer of the Vienna tramways in which this is the main reason given for the adoption of the railless system. Similar reasons for the adoption of the system in Shanghai were recently made public. The use of trailer cars is also made possible, and the practice obtains abroad, notably in South Africa.

In cases where the renewal of tramway permanent way presents a serious outlay, the installation of the railless system affords an inexpensive solution of the difficulty. In several northern towns the trolley-'bus runs over the same track as the existing tram-cars without the use of a second wire. This is accomplished by "Cross's steerer," which consists essentially of a plough running in the slot of the rail, which acts as a guide, the rear end of the plough being bolted to one of the stub-axles, which is thus swivelled when a change of direction in the rail occurs. The steerer is in electrical communication with the negative side of the motors, and a return path for the current is established. When in use the motor-man is simply concerned with the speed control of the vehicle.

The author concluded his paper with a brief description of the types of chassis of the Associated Equipment Co., Bradford Corporation, J. G. Brill Co. (Philadelphia), Clough-Smith & Co., Electric Traction Co., of Leeds, and Railless, Ltd., London.

An appendix shows that of the 33 authorities in the British Isles which have Parliamentary powers to run railless electric cars only 13 are exercising such powers, while one service has been abandoned.

It does not appear that any general regulations are issued in connection with railless electric traction. Special orders, which embody such regulations as are necessary, are made by the Ministry of Transport in respect of each system authorised.

Discussion.

Mr. Dudley Battey said the single-motor equipment was not uneconomical in practice. He was interested in a single-motor equipment, and on a service test lasting 10 hours the 'bus was loaded to 8¼ tons, which was the equivalent of 53 passengers; stops were made, and the route contained a maximum gradient of 1 in 9. The average consumption was 1¼ kWh per car-mile, or 150 watt-hours per ton mile. Since that test was made the 'buses, with the give-and-take loads of ordinary service, had run with something under 1 kWh per car-mile. The price paid for electricity was 1½d. per kWh, and at those figures he thought there was something to be said for the single-motor equipment. The energy economy of the single-motor trolley-'bus he had referred to was attributed to the method of control. Acceleration was obtained by the foot operation of the controller and also by the automatic shunting of the motor field. Acceleration was a function of speed, and the shunt was operated by means of a centrifugal governor worked off the motor shaft. The acceleration of the trolley-'bus was better than that of the average petrol-bus, both unloaded and loaded. With regard to tractive effort, the petrol-'bus had a slight advantage. The trolley-'bus had its own sphere of operation, especially in those cases where it could be used as a feeder to tramway systems and where electrical energy was cheap. The fact that it was tied to a particular route by reason of its overhead wires might be to its own advantage from the fact that it ensured transport to the neighbourhood, and thus helped in its development.

Mr. H. B. Benny said the comparative figures of costs in the paper seemed to have been arrived at in a very strange way. The author took petrol at 2s. per gallon, and electricity at 2d. per kWh. The figure of 2d. per kWh was a very fair one, but 2s. was the retail price of petrol, and a 'bus company would pay very much less than that. Similarly, the figures for cleaning and lubrication in the case of the motor-'bus were higher than those obtained in practice, whilst the figures given for repairs and maintenance were much too high. He had been through the estimated costs, and suggested that truer figures would be 17.65d. per mile for the petrol-'bus and 19.4d. for the trolley-'bus. The only proper comparison, however, would be on the basis of actual running costs of both types of vehicle.

Mr. F. Ayton remarked that there was a distinct sphere of utility for every type of commercial traction that existed. The petrol vehicle did not need any defence, but he did not hesitate to say that they would see in the future a very large extension of the use of the railless vehicle for both passengers and goods. The tendency was for the cost of liquid fuel to go up, whilst the price of electricity was certainly going to be less in the near future. It would not be long before the price would be down to 1d. per kWh, if not below. The advantage of the trolley-'bus, however, did not depend on the comparison of the cost of power. It had other advantages, and the Birmingham Corporation, with very great and considerable experience in the running of petrol-'buses, did not adopt the trolley-'bus except with one aim in view, *viz.*, getting the cheapest form of traction for the particular purpose. A year ago he went about the country examining the different railless trolley systems in use, and they were all giving very good service. He rather inclined to the single-motor equipment against the double motor, but it had to be recognised that the Railless Co.'s vehicles were giving very good service, and were running very well indeed.

The President (Lieut.-Col. D. J. Smith) thought the electric 'bus would have a great future, but it would not be the trolley-'bus. The day was not very far distant when public service vehicles such as electric omnibuses would obtain their power from another source than from overhead wires. Practically every tramway undertaking in this country was conducted at a vast loss; how vast they could never find out. Although the trolley-'bus possessed a certain flexibility, it was really only relative, because it was absolutely tied to its own track. A breakdown at the central station hung up the whole service and, if the roads were up, the trolley-'bus had got to go over what bit of road was left. The trolley-'bus was very little less objectionable, or rather, had very few less drawbacks, than the tramway.

The Author, in reply to the discussion, said that the price of petrol was high, but that was balanced by the fact that the price of electricity was also very high. A fair figure would be 1¾d. per kWh, and in some places it was 1½d. or 1¼d., whilst on the Tees-side it was only ¼d. per kWh. The ratio of the various items in the estimated costs was borne out fairly well in practice. At York the working costs up to September 30th last were 15.3d. per mile for the tramways, 17.26d. for the petrol-'buses, and 10.68d. per mile for the railless vehicles. As to the use of railless vehicles in Birmingham, the route was three miles, and it superseded the tramway service. The maximum gradient was 9 per cent. There were 12 cars operating the service, which was a four-minute one, and there were seven stops per mile, the average speed being 10 miles an hour. The vehicles were double-deck and seated 51 passengers, the weight (unloaded) being just over 7 tons. They were equipped with two 42-h.p. motors, and they ran up the 9 per cent. gradient at about 15 miles per hour. There was a lot of opposition in the Birmingham City Council to the adoption of the railless vehicle because they were all tramway and motor-'bus men there, but the logic of the circumstances had forced them to use railless traction. It was the only solution of the difficulty, and the railless vehicles were now running over the existing tramway lines and doing very well.

In a letter criticising the paper, Messrs. Clough, Smith and Co., Ltd., said the Strakes-Clough railless vehicles running at Rotherham and Tees-side had an actual cost of ¼d. per car-mile for tires as against the author's estimate of ¾d., and it was contended that a saving of ¼d. per mile over a petrol-'bus could safely be relied upon. Tests had been made in actual service with their single-motor equipment railless-'bus against a vehicle with a two-motor equipment, and it was found that the single-motor vehicle took less electricity than the other, and it was added that the following authorities, after having used vehicles with two-motor equipments, had now standardised single-motor equipments, *viz.*, Bradford Corporation, Rotherham Corporation, Ramsbottom U.D.C., Tees-side Railless Traction, Ltd., and the Bloemfontein municipality.

THE IMPROVEMENT OF POWER FACTOR.

Discussion at Manchester.

The paper on the above subject, by the late Dr. G. Kapp, which was abstracted in our issue of November 24th, 1922, was read by Prof. M. Walker, and discussed at the North-Western Centre of the Institution of Electrical Engineers on November 28th, when Mr. L. H. A. Carr thought that as the consumer had to pay for the power factor correcting apparatus, it was up to the supply authorities to persuade him to use it by making some difference in their tariffs. It was obviously uneconomical for the consumer to install more expensive machines in order to get a better power-factor if he was to derive no benefit from doing so.

One type of machine for power-factor correction had been ignored altogether in the paper. It was to be regretted that Dr. Kapp had said so little about the ordinary salient-pole synchronous motor with a squirrel-cage starting winding. It should be emphasised, particularly since the paper would probably become a classic, that that machine was probably the most widely used machine for power-factor correction; further, it should be recorded that the machine was made by all the manufacturers of medium and large sized machines in the country.

Mr. S. J. Watson suggested that to those who were engaged in industrial activities, the main reason for the use of power-factor correction was the adoption of motors with a very small percentage of their full rated duty, a thing they could not altogether provide against, although he thought improvement in that direction was taking place by grouping machines on one motor rather than utilising individual drives. Tariffs were exceedingly important and sooner or later some modifications would have to be made in tariffs to compensate for the money which had been spent, but was not being utilised for the purpose for which it was provided. There ought to be one tariff based upon the actual kW demand, and a somewhat lower figure for the difference between kW and kVA, because the costs which one incurred in connection with generating and transmission were not all based on kVA but on kW. For instance, the whole of the boiler-house equipment was based on a kW charge; therefore, if one had a figure per kW—say, £4—one was not entitled to charge the same price if the kVA came out at a higher figure. The fairest way would be to charge the £4 per kW and charge for the difference between the kW and the kVA at a somewhat lower figure, possibly of the order of £2 or £3.

The question who should provide the power-factor correcting device was of considerable importance. In the majority of cases it would be found expedient (in the best interests of the consumer)) to install apparatus to provide the correction, and consumers would be encouraged to do that if they knew they would, as a consequence, obtain an appreciable reduction in their accounts.

Mr. G. S. L. Reece said that if p.f. correction could be made more thoroughly understood a great deal more apparatus would be used. The Electrical Development Association seemed to be concerned very much with pushing heating apparatus; if it pushed this question it would prevent apparatus from becoming heated. The power companies appeared to have considered power-factor correction more than the municipal authorities.

Mr. H. C. Lamb knew of an instance where a rotary condenser had been installed on a Manchester consumer's premises for the improvement of power-factor in 1917. They were in Manchester in a very happy position as regarded power-factor, because such a large proportion of the power was converted to d.c., with the result that at times of maximum demand the power-factor was over 90 per cent. Some of the converting plant had a slightly leading power-factor and the remainder of the power, which was used as a.c., had a power-factor of over 80 per cent. Municipal engineers were not less keen than company engineers about getting the most economical result, but power companies had no traction supply; they converted practically nothing to direct current and therefore their power-factors were very often very low indeed.

Regarding Prof. Miles Walker's suggestion that a fixed charge based on kVA was the only sound system, there was something to be said on the other side, because it was the continuous power-factor that mattered and not merely the power-factor at the time of maximum demand. The Manchester tariff gave the consumer a rebate on his converted power-factor taken over a period, the average power-factor being obtained by the readings of two single-phase watt-hour meters taken over a monthly or a quarterly period. If the average power-factor so obtained was over 80 per cent. the consumer was allowed a discount for every 1 per cent. improvement; similarly there was a penalty if the power factor fell below 80 per cent.

Mr. L. Romero said that the practices of various power companies in varying their charges to compensate for power-factor correction all seemed to be different, and in his opinion they were all inequitable. Charging so much per kVA instead of per kW was quite inequitable. In Salford they had devised a system of charging (based on the actual costs as nearly as possible) of so much per kW per annum, and so much per kWh, subject to graded discounts as the power-factor fell below unity. That was a fair system and the matter ought to be standardised.

Mr. S. Corlett said that in mining plant one had to consider that all rotating arrangements for correcting power-factor could only be applied when they were rotating. There were relatively few continuous operations about a colliery except that of ventilation, and for many reasons one hesitated at times about installing a synchronous motor for driving a mine fan. He was responsible for purchasing electricity under various types of agreement in different parts of the country from public and municipal authorities, and said the different principles of charging might be summarised as a plain flat rate, a differential rate—one rate by day and a lower rate by night and at week-ends—and the rest (by far the greatest number) a maximum demand basis, plus a kWh charge. In many of those cases he had taken up the question of a consideration for an improvement in power-factor, and in one or two instances he had been met with a flat refusal—"not a single copper off the bill." Obviously, one could not recommend a customer under these conditions to spend any money. In other cases he had had concessions offered, but the practical result in pounds, shillings, and pence had been so small as not to justify any expenditure. He had used, with extremely satisfactory results, a private plant where they had their own generators and static condensers. It was seldom that a rotary power-factor correcting device could be attached to the particular motor, or group of motors, which caused the bad power-factor.

Mr. A. B. Mallinson pointed out that he had ventured to suggest last year that the supply authorities should give an inducement to customers to put in machines that would improve their power-factor, and he was rather ridiculed for thinking such a thing could be done. However, the seed seemed to have been sown and was bearing fruit, though some seemed to think it was rather slow growing. It was all right saying: "Get the customer to pay for the improvement device when he is putting his machines in," but were the machines absolutely as reliable as the simple motor he would otherwise install? Particularly was that important when one remembered that almost invariably such a device would be on the most important drive in the installation, one that would run day and night.

Mr. Cheetham thought that the diversity of power-factor tariffs was, to some extent, due to the difficulty of measuring kVA. It was possible to get a fair approximation to kVA measurement provided the range of power-factor was known to begin with, and much work was being done in that connection at the present time.

Mr. Mallalieu said that the static condenser, which had been applied to large plant, was absolutely reliable. If the supply authorities would educate the consumer as to the advantages of power-factor improvement, and give him a financial benefit, users in turn would buy the apparatus which could be readily supplied. It was really a move on the part of the supply authorities which was wanted now. That the cause of bad power-factor was largely to be found in underloaded motors and small motors was quite true, but the use of larger motors and group driving as against smaller motors was entirely against present-day practice and against future development. The full advantage of electrical transmission was only realised when the motor was brought up to the machine, and it was no good bringing electricity to the factory and then putting a large motor in the place of a steam engine. They must give the best service for the particular operations involved and leave power-factor improvement to the experts who were capable of dealing with it.

Mr. Purrett said that one point that had been overlooked was that tariffs were generally based on an average, and on a large distributing system it would not be fair to charge or penalise a consumer for bad power factor if he was not to be given the benefit of the geographical position. In view of the fact that in some instances consumers were 10 or 15 miles away from the power station he failed to see how one could arrive at an equitable tariff taking the power-factor into consideration. The improvement of power-factor at the end of a long feeder of several thousand kW in every case had been found not to be a commercial proposition. It would rather pay to put in extra feeder capacity than to install apparatus and incur the losses the improvement of power-factor would involve.

Mr. Fry thought the tendency of the large power consumers to-day was to install p.f. correcting machines and, if possible, to improve their regulation rather than duplicate their feeders.

Prof. Miles Walker said that perhaps sufficient notice had not been taken of the opening paragraph in the paper which was really the text of the whole matter. Dr. Kapp pointed out very clearly that it was possible to make such a substantial saving in the actual cost of the plant that there ought to be a good sum available to pay to the consumer. That he stressed very emphatically indeed. If those interested in the

matter would get together and come to some agreement amongst themselves as to what allowance should be made, and it was proved that it could be done properly and efficiently, then there was little doubt that power-factor improvement would take place.

Discussion at Liverpool.

THE paper was read by Prof. M. Walker at the Liverpool Sub-Centre of the North-Western Centre on November 27th.

MR. E. M. HOLLINGSWORTH said that the practice of installing motors of considerably greater power than was necessary in many cases was in no small measure the cause of the low power factor many supply undertakings were faced with. Therefore, it was necessary to keep in touch with consumers, to point out the advisability of installing suitable motors and letting them understand that the a.c. motor was capable of withstanding a considerable overload without any risk of failure.

MR. L. BREACH felt that the subject was treated from the wrong end, and that there ought not to be any necessity to improve the power factor of the system, but rather to improve the design of the apparatus connected thereto. The kVA maximum-demand charge, with kWh charged for at a flat rate by a cosine meter, required much less explaining than the preference and penalty method which became very complicated.

MR. H. HIGHAM pointed out that it frequently occurred that the first cost of a static condenser was higher than that of other apparatus put forward for power-factor correction, but on comparing running losses, amount of attention required, &c., it was found that the static condenser was cheaper in the long run. Synchronous motors for power-factor correction, and at the same time to do useful work, in some cases were not very economical. A suitable, accurate, kVA meter would considerably assist supply authorities to arrange their tariffs.

MR. F. J. TEAGO drew attention to the diagram and note by Prof. Miles Walker at the foot of page 2 of the paper,

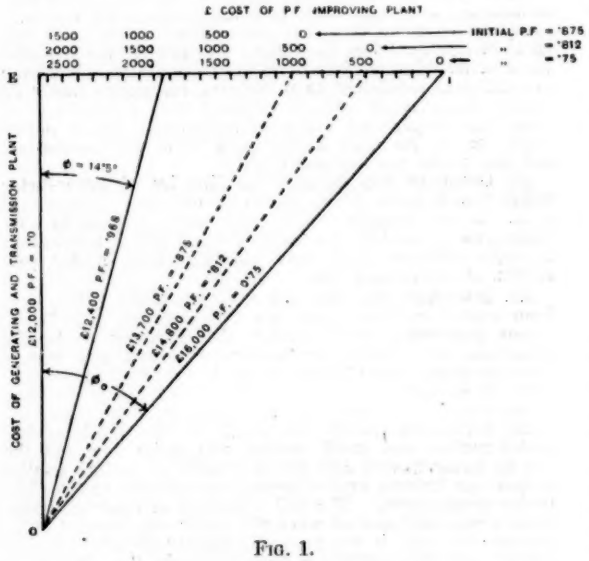

£ COST OF P.F. IMPROVING PLANT
INITIAL P.F. = '875
INITIAL P.F. = '812
INITIAL P.F. = '75
COST OF GENERATING AND TRANSMISSION PLANT
£12,000 P.F. = 1·0
£13,400 P.F. = '968
£13,700 P.F. = '875
£14,800 P.F. = '812
£16,000 P.F. = '775

FIG. 1.

which enabled the matter on page 3 to be represented in a graphical form. In the triangle OEI (fig. 1) the angle $\phi°$ had a cosine equal to 0.75. If the length of the vector OE represented the cost of the electrical plant at unity power factor, that was £12,000. The length of the vector OI would then represent the cost, £16,000, at a lagging power factor of 0.75, and the length of any other vector between O and the EI would represent the cost at a power factor equal to the cosine of the angle between that vector and the vector OE. Now, to a suitable scale, the length of the vector IE represented the cost of the power-factor-improving plant. If the value of the ratio C/C=1, then the scale of EI equalled the scale of OE. In that particular case C/C equalled 0.25, so that the scale of EI was four times that of OE. Mark off from I along IE a cost scale as shown in fig. 1, and join O to convenient points on that cost scale. Then, on improving the power factor from 0.75 to 0.812, the net saving would be: Original cost of plant—new cost of plant—cost of power-factor improving plant, *i.e.*, £16,000−14,800−500=£700, and per cent. saving=700×100/16,000=4.4 approximately. Repeat that for other values of the improved power factor and plot the results as shown by the full curve in fig. 2, which indicated that the maximum percentage saving equalled 11, and corresponded to an expenditure of £1,840 on improving plant. From fig. 1 it would be seen that the angle at which that maximum occurred was ϕ=14.5 deg., and the power factor was 0.968. Now take an angle to commence with, having a cosine of 0.812. The zero value of the cost of the improving plant under those conditions coincided with the original value, £500. On improving the power factor from 0.812 to 0.875, the net saving would be £14,800−13,700−500=£600 and per cent. saving=600×100/14,800=4.1 approximately. Repeat as before and plot the results as shown by the dotted curve in fig. 2, which indicated that the maximum percentage saving equalled 7.2, and corresponded to an expenditure of £1,340 on improving plant, and that expenditure under the new conditions corresponded to exactly the same improved power factor as an expenditure of £1,840 under the old conditions. The constant angle ϕ=14.5 deg., the sine of which=0.25. Thus, as Prof. Kapp pointed out, ϕ depended solely on the value of the ratio C/Y, and was independent of the original value of the angle $\phi°$.

MR. T. E. HOUGHTON thought that Dr. Kapp's mathematical determination of the most economical value of the power factor to which a system could be brought only applied to a new private installation, and did not hold in the case of a consumer whose present power factor required improving. Nevertheless, it was possible to deduce a mathematical relation in the latter case also. Assuming a maximum demand tariff based on kVA, the economical phase angle for a consumer so charged could be determined from $\sin\phi = Y/X$, where Y= annual, plus running, charges per kVA of phase-advancing plant, and X=charge per kVA per annum of maximum demand; shorter periods could be used to suit individual cases. Taking usual values of X and Y, $\cos\phi$ approximated to unity. It was also possible to deduce a formula for the case in which it was desired to reduce the losses in a transmission or distribution system by improving the power factor: the economic phase angle was given by $\tan\phi = 50/K \times Y/M$, where K= percentage losses at unity power factor, M = actual cost per kW per annum and Y as above; in this case also $\cos\phi$ approximated to unity. It was significant that Dr. Kapp's expression, and those given above, all gave values of the economic power factor very near to unity, whereas it had been generally accepted that improvement in power factor should not be carried much beyond 0.9.

DR. E. W. MARCHANT said that a long overhead transmission line had very considerable self-induction and considerable

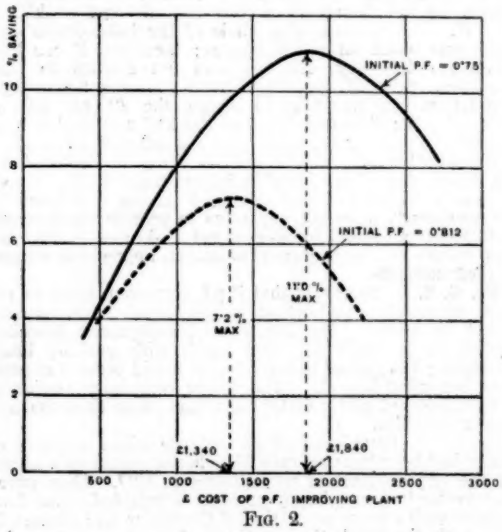


FIG. 2.

capacity. For a 200-mile transmission line of three overhead conductors, each of 0.36 in. diameter, spaced 6 ft. apart, the capacity effect was very considerably in excess of the reactive effect due to self-induction. For small motors static condensers were the cheapest method of correcting power factor. For larger machines the phase advancer might be less in capital cost, but a condenser required roughly

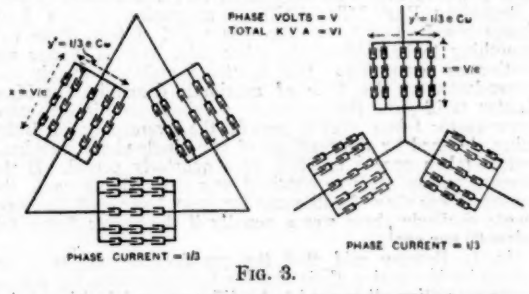


FIG. 3.

one-third of the power that was used by a phase advancer. The actual power loss was small, and the cost of the extra energy used per annum would probably be compensated for by the smaller capital charge due to the phase advancer.

MR. J. C. PRESCOTT drew attention to the fact that the

number of condenser units required to absorb a given amount of lagging kVA was found from the equation $n = p10^9/\omega ce^2$. Although that would, in general, give the exact number, certain other conditions must be fulfilled for a balanced poly-phase load. In the first case n must be divisible by the number of phases and, further, the units for each phase must be capable of arrangement in an integral number of lines, each line containing an integral number of units. Thus, in the three-phase case (as shown in fig. 3) there must be $1/3ec\omega$ complete lines in parallel, each consisting of v/e units.

Mr. Charles Rettie said that the paper dealt only with land practice, but in many respects was applicable to the electrical propulsion of ships, though the problems of one might differ from those of the other. Synchronous motors were not suitable for the electrical propulsion of ships; the induction motor was the best, provided some means could be adopted to raise the power factor, such as by the use of phase advancers.

Mr. A. E. Malpas said, from the point of view of the user, that he agreed with the view that for a moderate-sized installation at all events the static-condenser method was still the best, although in future it might be that some of the more modern types of rotary device would be more and more adopted. The average user, however, moved slowly and attached more importance, as a rule, to reliability than to the last word in improved power factor.

Dr. T. F. Wall, in connection with deduction of the magnitude of the condenser capacity to which the vibrator was equivalent, showed how to obtain algebraical expressions by means of which the performance of the motor could be calculated for any value of the slip and for any value of the equivalent condenser capacity. The expressions were most easily derived from the equivalent circuit by the use of complex quantities. Similar expressions for the other characteristic quantities were easily obtained.

THE OMNI-RANGE AND OTHER PORTABLE CURRENT TRANSFORMERS.

SOME EVERETT, EDGCUMBE INSTRUMENTS.

Whilst the accuracy and general usefulness of instruments for direct current has steadily increased, that of the corresponding instruments for alternating current has lagged behind, owing principally to the lack of accurate current and voltage transformers—more particularly the former.

The current transformer bears the same relation to an a.c. ammeter or wattmeter as does the shunt to a moving-coil ammeter, and from this it follows that a current transformer should have an accuracy comparable with that of the measuring instrument with which it is to be used—a condition by no means easy of fulfilment.

Fig. 1 gives an elementary vector diagram of a current transformer, assumed, for convenience, to have an equal number of primary and secondary turns, and this diagram will serve to illustrate the difficulties involved in the design. Starting with the flux in the core (Φ), there is a magnetising current (Im) in phase, and an iron losses current (Il) in quadrature, with it. These two currents combine to form what may be called the no-load current (Io). The flux (Φ) induces a voltage, E, in the secondary winding, 90 degrees out of phase with itself, and this, in its turn, produces a current, I_2, in the secondary circuit. I_2 will lag behind E by an angle ϕ, the value of which depends upon the impedance of the secondary load—or upon the "burden," as it is perhaps better called.

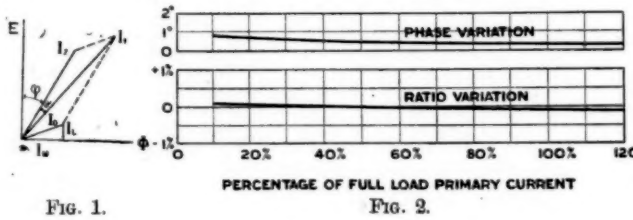


Fig. 1.

Fig. 2.

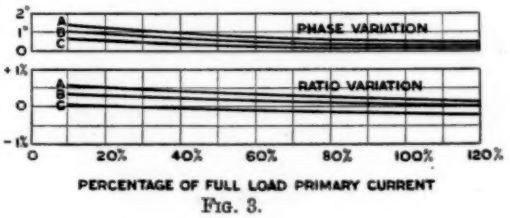


Fig. 3.

It is clear that the primary current, I_1, has to supply the no-load current, I_o, as well as the secondary current, I_2, and hence it follows that I_2 is slightly out of phase with I_1 (leading, in fact, by the angle α), and is also slightly less in magnitude than I_1.

It is the object of the designer to reduce the angle α to the smallest possible value and, at the same time, to make the ratio of I_1 to I_2 constant at all currents and all loads.*

A little consideration will show that both these requirements are best met by reducing the values of Im and Il to a minimum, and experience shows that a large magnetising current is the more harmful. It will, moreover, be evident that with any given design of core, the greater the number of primary turns for a given primary current the better will be the performance, since the length of the vector I_1 will vary directly as the number of primary turns, whereas the length of I_o is invariable.†

From the point of view of accuracy, the smaller the burden (*i.e.*, the impedance of the secondary circuit) the better, since the value of E required to force a given current, I_2, through the secondary is directly proportional to this impedance, and any increase in E involves a corresponding increase in Φ and, with it, in Im and Il.

From what has been said, therefore, it is clear that efficiency lies in the direction of low-flux density; best-quality iron; high ampere-turns; short magnetic circuit; small magnetic leakage; and absence of joints in the magnetic circuit.

The difficulties in the way of a successful design increase, as has been shown, with the secondary burden—in fact, as a rough approximation, it may be said that the product of ampere-turns into cross-section must be increased in direct proportion to the burden. From this it follows that a reasonably accurate current transformer with a straight-through primary, for less than 200 amperes becomes extremely bulky. But, fortunately, the use of such transformers is usually restricted to switchboard work, where great accuracy is not called for. In the case of portable current transformers, such as we are now considering, it is usually possible to provide for 1,000 or more ampere-turns at rated primary current.

How well Messrs. Everett, Edgcumbe have succeeded in embodying the ideals enumerated will be apparent from an inspection of fig. 2, which gives the results of some tests made by the National Physical Laboratory on an Everett-Edgcumbe portable multi-range current transformer. From these curves it will be seen that the ratio is correct to within one part in a thousand at all points from one-tenth load up to 20 per cent. overload. The tests were made with a secondary burden corresponding to 10 volt-amperes at full load. When the burden was increased to 17 volt-amperes the change of ratio proved to be less than one part in a thousand, and the change in phase angle was too small to be measured.

Fig. 3 shows the effect of a still larger change of burden, on a similar current transformer, curve C being obtained with 5 volt-amperes, curve B with 15 volt-amperes, and curve A with 40 volt-amperes. From these curves it will be seen that the greatest ratio error, down to one-tenth load, does not exceed ½ per cent. with any secondary burden up to 40 volt-amperes at rated secondary current.

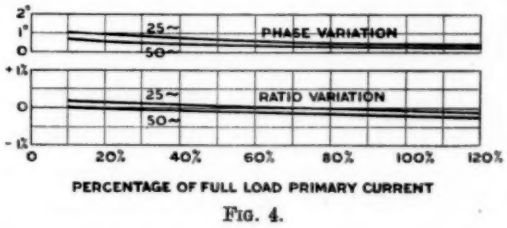


Fig. 4.

In the case of portable testing transformers, the effect of heavy secondary burdens is of less interest than that of changes of frequency. Fig. 4 shows this effect with a secondary burden of 10 volt-amperes. It will be seen that the difference in ratio between 25 cycles and 50 cycles is less than two parts in a thousand, and the difference in phase displacement ranges from about four minutes at full current to some 15 minutes at one-tenth current.

* It is easy to make this ratio unity at any particular current by adopting a suitable ratio for the number of primary and secondary turns.

† Since the current vectors in fig. 1 actually represent ampere-turns and not amperes.

The true criterion of the suitability of a current transformer for the purpose in view is the effect which it has on the final accuracy of a measurement. The result of a ratio error is obviously to produce a corresponding error in the instrument reading, and from the data already given it is clear that for practical purposes this error, in the case of an Everett-Edgcumbe current transformer, is nil. The error introduced by the phase angle is less easy to gauge, and is most noticeable in the case of a power measurement by means of a wattmeter. It can be shown that the error in such a case is proportional to $\sin \alpha \tan \phi$—that is to say, it varies widely with the power-factor of the load.

Fig. 5 shows, graphically, how the accuracy of a power measurement is affected by the phase displacement of an Everett-Edgcumbe current transformer, such as that for which the constants are given in fig. 2. From fig. 5 it

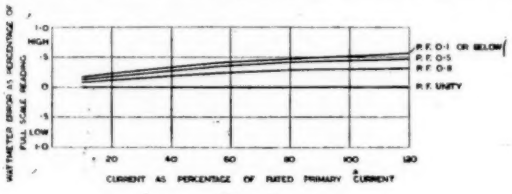


Fig. 5.

will be seen that at unity power-factor no error whatever is observable, and that at any power-factor, down to zero, the greatest error at any point on the scale is five parts in a thousand.

It is evident, then, that the Everett-Edgcumbe portable current transformer fulfils the most stringent requirements, as regards accuracy, and the next problem which arises concerns the most suitable ranges or combination of ranges. This necessarily depends upon the requirements of each particular case. If the range of currents to be dealt with is restricted, a current transformer with a single primary will probably suffice. Such a transformer may be considered to have a useful range of from 10 per cent. to 150 per cent. of its rated primary current, *e.g.*, 10 amperes to 150 amperes (in the case of a current transformer rated at 100 amperes),

Fig. 6.

and this range can be doubled or quadrupled if the primary windings are arranged for series and parallel connection. Fig. 6 shows such a transformer having ranges of 20, 40, and 80 amperes, and therefore available for measurements ranging from, say, 2 up to 120 amperes. In the case of low-pressure systems the straight-through range of the instrument itself (say 1 to 6 amperes) can also be made use of.

When, as is most likely, a wider range of currents is required, separate primary windings are provided. For example, ranges of 20, 100, and 500 amperes form a useful combination, giving a total range of measurement from, say, 4 to 750 amperes. In the majority of cases a still wider range has to be covered, hitherto necessitating the use of two, or often of three, separate transformers.

In their Omni-range current transformer, however, Messrs. Everett, Edgcumbe have evolved a model which has an almost unlimited range. Fig. 7 shows one of these transformers, which consists of a ring core with two or more low-range primaries and a circular opening in the centre. The transformer illustrated has primaries for 5, 20, and 100 amperes, and by threading a length of cable through the centre opening a given number of times, as shown in the illustration, ranges of 400, 500, 1,000, and 2,000 amperes are readily obtained. Such a current transformer will deal with currents ranging from, say, 1 up to 3,000 amperes, so that the name "Omni-range" is well deserved.

Besides the great portability and convenience of these Omni-range current transformers, they have a further important advantage in that the ratio and phase displacement curves are identical on all ranges, which is often far from being the case when a number of distinct transformers of ordinary construction are used. This feature is of particular value when it is a question of determining the ratio and phase displacement of other current transformers by the comparison method which, although much the most accurate and expeditious, involves the use of a comparison transformer, the ratio and phase characteristics of which are accurately known and which has a variable ratio. For this purpose the multi-range

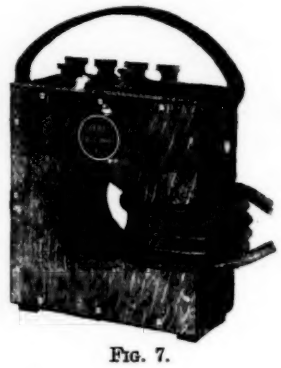


Fig. 7.

current transformer is ideal, since any number of intermediate ratios can be arranged for, if desired, by means of tappings on the secondary.

In this connection it may be added that Messrs. Everett, Edgcumbe have developed an extremely expeditious and accurate method of measuring the ratio and phase displacement of current and potential transformers, which has been in use at their factory for a considerable time.

THE PORTSMOUTH ELECTRICITY UNDERTAKING.

Inauguration of New Plant.

The building of the electricity generating station of the County Borough of Portsmouth was begun in October, 1892. The original plant consisted of two 200-kW alternators, coupled direct to low-speed horizontal engines, and five Lancashire boilers. These sets were the first directly-coupled alternators to be installed in a public power station. Another very novel feature in those days was the Ferranti rectifiers for supplying the street arc lamps, these also being the first of that type ever installed.

The public supply of electricity was started in June, 1894, and the increase of its use led to extensions in 1903, 1907, and 1915, although the last was not completed until 1919. After the war the opportunity was seized of reconstructing the whole station (with the exception of that part of the new engine room erected in 1907) and it was decided to discard the old system of single-phase generation and to adopt the three-phase system, the new steam pressure adopted being 250 lb. per sq. in.

For the production of steam while the old boilers were out and before the new boilers were ready, a new water-tube boiler was erected in a temporary position, and induced-draught plant was installed on five of the remaining Lancashire boilers, in order to obtain an increased output. The first of the two new boilers was completed in December, 1921, and the second in March, 1922; the economisers to serve these two boilers are now nearing completion. The erection of the new generating plant was commenced in September, 1922, and the cost of the extensions so far completed is slightly over £100,000.

The site of the station is favourably situated for an adequate supply of cooling water from the sea for the condensers.

The whole of the plans, specifications, drawings, &c., were prepared by the department's permanent staff; the whole of the constructional work was carried out by direct labour. Mr. B. Handley is the engineer and manager, and the principal contractors for the extensions were the Metropolitan-Vickers Electrical Co., Ltd.: one 4,000-kW turbo-alternator with condensing plant, &c. Messrs. Babcock & Wilcox, Ltd.: two water-tube boilers, each of 30,000 lb. per hour capacity; bunkers, elevator, and conveyor. The General Electric Co., Ltd.: switchgear. The British Electric Transformer Co., Ltd.: Scott-connected transformers, 6,600 volts, 3-phase, 2,200 volts, 2-phase, 4,500 kVA capacity.

Of course, the supply of electricity had to be maintained during the whole time the work was in progress, and the culminating point of the difficulties was last autumn, when to meet a daily maximum demand of 4,000 kW, the whole of the generating plant in the station only totalled 3,000 kW. One indignant consumer aptly described the situation by complaining that the "electric light had become as bad as the gas."

The further extensions which were officially inaugurated on January 16th are: One 4,000-kW Fraser & Chalmers-G.E.C. turbo-alternator, and two water-tube boilers, bunkers, &c., by Messrs. Babcock & Wilcox, Ltd. The capacity of the station when these further extensions are completed, and making allowance for all old plant to be superseded, will be 11,000 kW generating plant and 140,000 lb. per hr. boiler plant. The number of consumers now on the mains is 14,700. The number of new connections for the past two years has averaged 7 per working day.

The Mayor of Portsmouth (Ald. F. G. Foster, J.P.) performed the ceremony of starting the new plant, and after it had been placed on load, the company, which included the engineers from several of the neighbouring towns, as well as representatives of the various contracting firms, were entertained to tea by the chairman of the Committee in charge of the department (Councillor A. Hemingway). In the course of the speeches, it was stated that further extensions were contemplated, including another 4,000-kW turbo-alternator and two more water-tube boilers. This was necessary in order to have a stand-by for the largest machine in the works. Reference was also made to the difficulty under which the engineer (Mr. B. Handley) and his staff had to work during the period of reconstruction. Such was the need of the new boilers that when the first had been completed it was put on the range at once although it was practically out in the open air, without a roof or any other protection than temporary expedients to keep off the rain. The chairman said that an order had been obtained to supply the districts of Havant and Emsworth, and extensions were also being made in the town of Portsmouth itself at a great rate. Last year 5,214,138 kWh was sold, producing a revenue of £123,756. The number of consumers was now 14,700, and since last March they had connected no fewer than 3,500 new customers. The Mayor was presented by the members of the Committee with a silver-mounted inkstand suitably inscribed as a memento of the occasion.

LEGAL.

Marconi's Wireless Telegraph Co., Ltd., v. Mullard Radio Valve Co., Ltd.

THIS case came before the Court of Appeal, consisting of the Master of the Rolls and Lords Justices Warrington and Younger, on January 24th upon the appeal of the plaintiffs and the cross-appeal of the defendants from the judgment of Mr. Justice P. O. Lawrence in the Chancery Division.

The plaintiffs brought the action for an injunction to restrain the defendants from infringing their letters patent No. 28,412, of 1913, and No. 126,658, of 1916, and for delivery up of the articles made in alleged infringement of the letters patent and also for damages. The case was reported in our issues of July 28th (p. 121) and August 11th (p. 215), 1922.

Defendants denied the alleged infringement. They admitted that they sold and manufactured considerable numbers of thermionic valves, but they alleged that in part such manufacture and sale was by them as agents or contractors of H.M. Government, and in particular the Admiralty, on written authorisation in that behalf and they denied that such valves constituted an infringement of either of the patents. Defendants also pleaded that at all material times the plaintiffs' letters patent had been invalid by reason of anticipation.

Mr. Justice LAWRENCE, in a considered judgment,* dismissed the action, and directed that the plaintiffs should pay the general costs of the action and the costs of the issue of infringement, the defendants to pay to the plaintiff company the costs involved by the attack on the validity of the letters patent of the plaintiff company. He also granted limited certificates of validity of the patents involved. From this result the plaintiffs and the defendants now appealed.

Mr. J. Hunter Gray, K.C., Mr. Jas. Whitehead, and Mr. Trevor Watson appeared for the plaintiffs; and Sir Duncan Kerly, K.C., Mr. R. Moritz, and Mr. Courtney Terrell for the defendants.

It appeared from the opening statement of Mr. GRAY that claim 3 of the specification of the patent of 1913, No. 28,413, read as follows:—"A vacuum tube containing a hot filament, a grid formed as a closed cylinder completely surrounding the filament, and a third electrode in the form of a cylinder surrounding the grid substantially as described." The plaintiffs' second patent, No. 126,658, contained the following clause:—"A vacuum apparatus intended to serve as relay or generator of maintained oscillations in which the filament, the grating, and the plate are concentrically arranged and fixed directly to the wires serving as conductors, these wires being sealed in the same glass tube soldered to the opening of the bulb, the filament placed in the centre of the system being stretched between two conductors having a certain elasticity and the grating formed of a specially rolled wire supported by its two ends, the plate being cylindrical and surrounding the two other elements by its two ends, the said plate being attached to the conductor by one or two hooks."

Plaintiffs' case was that defendants in what they had done had manufactured, used, and sold vacuum apparatus or valves made in accordance with the invention claimed in clause 3 of the specification of the letters patent of 1913, and in all the claiming clauses of the specification of the letters patent of 1916.

Defendants, while pleading that the plaintiffs' patents were invalid for want of subject matter, contended as to the specification of the letters patent of 1913 that their grid, which was a loose open ended cylinder, did not infringe the plaintiffs' device disclosed in claim 3 of the patent, and as to the second patent, defendants contended that the substance of the alleged invention there lay in the details, and that in their valve the details were different from those claimed.

In the course of his address, Mr. GRAY said that Marconi's invention first came on the market in 1896.

On Tuesday, at the close of the appellants' case, Sir DUNCAN KERLY, on behalf of the respondents, in support of the judgment of Mr. Justice Lawrence on the issue of infringement, said that the proposition that Round had before him was to have such a cover as would prevent the glass being electrified. He wanted to remove the troubles caused by the incalculable action of the possible ions. He did not say that his apparatus was directed to any new principles. He said that Von Lieben had introduced something which he (Round) was going to improve upon. In Von Lieben's valve there was no part of the glass which was protected from electrification, and there was not in Round's any grid at all which would be a protective grid for the glass. Appellants' case was that they had a claim for a principle, that the respondents had made use of it, and that their apparatus was within their claim. Round's apparatus was wholly useless for the conditions then obtaining.

The case was proceeding when we went to press.

* ELEC. REV., October 27th (p. 583) and November 10th (p. 683), 1922.

Charge Against Mr. W. T. Kerr, of Hereford.

THE following report is reproduced from the *Birmingham Post* of January 29th:—"A sensational sequel to the Hereford electricity controversies was the arrest in Gloucester, late on Friday night, and the appearance in the Hereford City Police Court on Saturday, of Walter Talbot Kerr, formerly electrical engineer to the Hereford Corporation. He was brought up on two charges of fraud, and it was stated that other charges would be formulated against him.

"The charges against Mr. Kerr, who lives at Tupsley, were that being an officer of the Hereford Corporation he unlawfully and fraudulently did apply for his own use the sums of £90 and £810 respectively, the property of the said Corporation, between June 22nd, 1920, and September 23rd, 1920.

"The CHIEF CONSTABLE said the two sums, making a total of £900, represented the purchase money received from the Western Electrical Co., at Swansea, for a 60-kilowatt Bellis Dick Kerr generating set belonging to the Corporation. The company paid £90, 10 per cent. deposit on the purchase money, to the defendant on or about June 22, 1920. The company sent a cheque for the balance to the defendant—a balance of about £810—about September 20th of the same year. The total sum of £900 was never paid over by the accused to the Corporation. On the contrary, the defendant reported to the City Council on November 23rd, 1920, that he had sold this generating set for £640, whereas two months earlier he had actually received the larger sum of £900. The defendant never paid over either the £640 or the £900.

"Proceeding, the CHIEF CONSTABLE said on Friday night he found the defendant in the lounge of a Gloucester hotel. He arrested him and brought him to Hereford. At Hereford the accused asked for particulars of the warrant on which he was arrested, and these were supplied to him.

"The accused was remanded till next Friday, bail being allowed of £2,000, himself in £1,000, and two sureties of £500 each. An order was also made to allow the Chief Constable to inspect the prisoner's bank accounts."

The *Manchester Daily Dispatch*, in reporting the matter, says:—"Kerr, a prominent Freemason, resigned his Corporation post twelve months ago to start a business in the Forest of Dean.

"MR. T. RAWSON, the Chief Constable, told the magistrates that Kerr had been in charge at Hereford of a very extensive scheme sanctioned by the Government for the supply of electricity to all parts of the country. Although this had to be abandoned, owing to financial difficulties, before its completion, cables had been erected to carry power to distant villages and farms."

Radium in the Belgian Congo.—Speaking in the Senate recently, the Minister for the Colonies, Mr. Franck, stated that radium could be produced in the Congo in such quantities as would render Belgium the supplier of the world. Eight grammes of radium bromide are to be reserved for the use of the hospitals in Belgium.—*Reuter* (Brussels).

NEW PATENTS APPLIED FOR, 1923.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by MESSRS. SEFTON-JONES, O'DELL AND STEPHENS, Patent Agents, 285, High Holborn, London, W.C. 1.

1,235. "Electric switches." W. L. Barber and Midland Electric Manufacturing Co., Ltd. January 15th.
1,243. "Safety switch." S. G. Jones. January 15th.
1,251. "Continuously variable rheostat for thermionic valves, &c." H. D. O'Mantle. January 15th.
1,252. "Crystal detectors, &c." H. D. O'Mantle. January 15th.
1,253. "Electric transformers, induction coils, &c." W. D. Burnett. January 15th.
1,259. "Movable mouthpiece receivers for use in fixed mouthpieces on telephone instruments." H. J. Saunders. January 15th.
1,263. "Miners' flame safety lamps, &c." T. Doleman. January 15th.
1,280. "Recording and reproduction of acoustic waves." L. A. L. Struxiano. January 15th. (France, January 20th, 1922.)
1,313. "Sound recordance and reproduction." W. F. Franklin. January 15th.
1,319. "Lighting system for headlights." A. Gaygal. January 15th. (France, January 16th, 1922.)
1,330. "Safety apparatus for mercury-vapour high-vacuum pumps." Akt. Ges. Brown, Boveri et Cie. January 15th. (Germany, June 6th, 1922.)
1,332. "Radio receiving systems." C. S. Franklin, S. B. Smith, B. J. Witt, and G. M. Wright. January 15th.
1,335. "Telephone systems." Western Electric Co., Ltd. (L. Polinkowsky). January 15th.
1,343. "Miners' lamps." Concordia Elektrizitäts Akt. Ges. and W. Gosmann. January 15th.
1,346. "Crystal detectors for wireless receiving apparatus." I. F. Taylor. January 15th.
1,350. "Ignition distributors." G. H. Taylor. January 15th.
1,357. "Semi-automatic telephone systems." Automatic Telephone Manufacturing Co., Ltd. (Automatic Electric Co.). January 15th.
1,378. "Receivers for wireless telegraphy, &c." A. M. Chalmers and C. V. Morris. January 16th.
1,397. "Buzzer magnets." R. Bosch Akt. Ges. January 16th. (Germany, January 20th, 1922.)
1,398. "Battery ignition devices for internal-combustion engines." R. Bosch Akt. Ges. January 16th. (Germany, January 23rd, 1922.)
1,399. "Magneto-electric ignition apparatus." R. Bosch Akt. Ges. January 16th. (Germany, January 18th, 1922.)
1,404. "Electric light for buoys." F. W. Yeo. January 16th.
1,424. "Electro deposition of metals." A. Waldberg. January 16th. (France, January 19th, 1922.)
1,441. "Electric switch." Internationalt Radiotelegraf and Telefon Compagnie ved Wahnöe and Peters. January 16th. (Denmark, January 20th, 1922.)
1,443. "Electric motor control systems." A. S. Cachemaille (Westinghouse Electric and Manufacturing Co.). January 16th.
1,444. "Electric motor control systems." A. S. Cachemaille (Westinghouse Electric and Manufacturing Co.). January 16th.
1,448. "Variometers, varicouplers, &c." J. A. Mendenhall. January 16th.
1,455. "Relay and coupler mechanism for electric organs, &c." F. P. Walker, R. H. Walker, and J. W. Walker & Sons, Ltd. January 16th.
1,458. "Systems of control of electric circuits." British Thomson-Houston Co., Ltd. (General Electric Co.). January 16th.
1,472. "Circuit-controlling means." R. Peale. January 16th.
1,475. "Signalling systems." Western Electric Co., Ltd. (Western Electric Co., Inc.). January 16th.
1,478. "Gramophones." Sterling Telephone and Electric Co., Ltd. January 16th.
1,482. "Containers for accumulators, miners' lamps, &c." W. Maurice. January 16th.
1,484. "Self-holding insulator." W. D. G. Rees. January 17th.
1,497. "Searchlights or projectors for vehicles." W. G. Riley. January 17th.
1,530. "Trolley heads for electric traction systems." E. E. Mathers. January 17th.
1,535. "Electric power transmission systems." A. M. Taylor. January 17th.
1,556. "Sparking plugs." E. A. Pye. January 17th.
1,557. "Thermostatic switch adaptors for electric circuits." Pryco, Ltd., and E. A. Pye. January 17th.
1,558. "Timing switch device for electric circuits." Pryco, Ltd., and E. A. Pye. January 17th.
1,565. "Thermionic valves." W. A. Brady. January 17th.
1,572. "Cooling electrodes of X-ray tubes." G. L. Hertz and Naamlooze Vennootschap Philips' Gloelampenfabrieken. January 17th.
1,573. "Automatic telephone systems." L. Sèmat. January 17th. (France, June 30th, 1922.)
1,576. "Electric switches." L. Appoullot. January 17th. (France, January 18th, 1922.)
1,578. "Electric valves and relays." W. H. Derriman and J. Robinson. January 17th.
1,585. "Renewable electric fuses." British Thomson-Houston Co., Ltd. (Compagnie Française pour l'Exploitation des Procédés Thomson-Houston). January 17th.
1,587. "Electrically-operated submarine sound signalling installations." H. Baron (Signal Ges.). January 17th.
1,592. "Sparking plugs." P. A. Davis, T. E. Davis, and F. Rowland. January 18th.
1,602. "Inductance coils for wireless apparatus, &c." J. D. Dunthorne and W. J. Rickets. January 18th.
1,606. "Electric motors for driving paper, &c., machines." B. James. January 18th.
1,607. "Alternating-current motors." B. James. January 18th.
1,614. "Electric heating and cooking apparatus." G. S. Gattell and G. H. Ide. January 18th.
1,621. "Electric dynamos." F. Westwood and S. C. Westwood. January 18th.
1,627. "Telephone call-recording apparatus." H. G. Humphreys. January 18th.
1,629. "Electric cables." A. E. Foster and Siemens Bros. & Co., Ltd. January 18th.
1,636. "Motor-car headlight." W. T. Coulson. January 18th.
1,639. "Guard for sparking-plug adaptors." E. B. Gnapp. January 18th.
1,642. "Dynamo-electric machines." E. W. Dorey. January 18th.
1,658. "Electric flash lamps, &c." H. St. G. Anson. January 18th.
1,667. Instrument relays." Cambridge & Paul Instrument Co., Ltd., and B . Robinson. January 18th.
1,671. "Electric lamp." H. E. Tvermoes. January 18th.
1,684. "Electric switches." British Thomson-Houston Co., Ltd. (General Electric Co.). January 18th.
1,688. "Telephone systems." Automatic Telephone Manufacturing Co., Ltd., and C. Gillings. January 18th.
1,689. "Commutators for electric machines." J. E. Calverley and W. E. Highfield. January 18th.
1,700. "Accumulator or battery boxes." H. H. Seddon. January 19th.
1,703. "Upward-current classifiers." R. Minikin. January 19th.
1,715. "Electro-medical appliance." R. A. Redmond. January 19th.
1,726. "Variable electric resistance." H. Richmond. January 19th.
1,731. "Methods of testing electric ignition of motor vehicles, &c." A. Fraser and J. B. Taunton. January 19th.
1,755. "Electric signalling devices." N. Straussler. January 19th.
1,762. "Time-lag electric switch." R. S. Allen. January 19th.
1,764. "Power-factor indicators for alternating-current systems." Chamberlain & Hookham, Ltd., and S. James. January 19th.
1,765. "Electric resistances." Akt. Ges. Kummler & Matter. January 19th. (Switzerland, January 30th, 1922.)
1,768. "Circuit-breaker systems." British Thomson-Houston Co., Ltd. (General Electric Co.). January 19th.
1,769. "High-tension electric switchgear." D. R. Davies and Metropolitan-Vickers Electrical Co., Ltd. January 19th.
1,782. "System of charging electric accumulators, &c." P. W. Wood. January 19th.
1,805. "Chain for suspending electroliers, chandeliers, &c." F. Stokes. January 20th.
1,817. "Indicating scales of variable condensers, &c., for wireless telephony, &c." R. L. Ryan. January 20th.
1,826. "Trolley wheel, &c., for overhead electric tramway systems." J. J. Jennison. January 20th.
1,856. "Electrical apparatus." British Thomson-Houston Co., Ltd., and A. P. Young. January 20th.
1,857. "Determination of cylic variation of current or pressure in electric circuits." H. E. Donnithorne and H. Kennedy & Co., Ltd. January 20th.
1,858. "Wireless communication." W. S. Hill and C. Seymour. January 20th.
1,872. "Production of asymmetrical alternating voltages." M. S. Stutchbury (Krause). January 20th.
1,874. "Electric switches." R. A. R. Bolton and English Electric Co., Ltd. January 20th.
1,877. "Wireless transmission and reception." E. T. Fisk. January 20th.

PUBLISHED SPECIFICATIONS.

The numbers in parentheses are those under which the specifications will be printed and abridged, and all subsequent proceedings will be taken.

1921.

18,342. "Keyboard perforators suitable for producing punched tape for use in automatic telegraphy." F. G. Creed and Creed & Co., Ltd. July 6th, 1921. (191,093.)
25,905. "Wireless signalling receiving systems." British Thomson-Houston Co., Ltd. (General Electric Co.). September 30th. (Cognate application, 26,431/21.) (191,125.)
26,238. "Electrically-heated vulcanising apparatus." W. Frost and Harvey Frost & Co., Ltd. October 4th, 1921. (191,143.)
26,308. "Electric heating apparatus." Phi-Kappa Syndicate, Ltd., and D. Watson. October 5th, 1921. (191,148.)
26,336. "Brakes for railway and tramway vehicles." T. Zweigbergk. October 5th, 1921. (191,149.)
26,354. "Submarine telegraph cables." H. W. Sullivan. October 5th, 1921. (Patent of addition not granted.) (191,151.)
26,417. "Commutators for dynamo-electric machines." E. C. Hatcher. October 6th, 1921. (191,157.)
26,449. "Electric inductances and inductance coils and the like." R. T. Smith. October 6th, 1921. (191,159.)
26,511. "Electric switches." A. Hougardy. October 7th, 1921. (191,161.)
26,673. "Electron discharge devices." British Thomson-Houston Co., Ltd. October 28th, 1920. (170,834.)
27,086. "Electric wall switches." E. C. R. Marks (McGill Manufacturing Co.). October 12th, 1921. (191,184.)
27,665. "Electrical actuating means for operating the type bars of typewriters and other key-controlled devices." A. E. White (Magnetic Power Transmitter Co.). October 18th, 1921. (191,195.)
28,853. "Electric burglar-alarm apparatus." H. Weeke and A. Hüther. October 31st. 1921. (191,212.)
28,897. "Electrical transformers." H. A. T. Packford. October 31st, 1921. (191,214.)
29,411. "Illuminated signs." E. T. R. Murray. November 4th, 1921. (191,220.)
30,185. "Electrical relays." S. G. Brown. November 11th, 1921. (191,228.)
32,963. "Electromotive drives for calculating machines." Optische Anstalt C. P. Goerz Akt. Ges. December 11th, 1920. (172,640.)
32,977. "Telephone systems." Western Electric Co., Ltd. (Western Electric Co., Inc.). December 8th, 1921. (191,257.)
34,677. "Switches for starting electric motors." C. A. M. Buckley. December 23rd, 1921. (191,273.)
34,706. "Terminal for electric wires or cables." J. W. V. Thurgood. December 24th, 1921. (191,275.)
34,786. "Dimming device for use in connection with electric lamps for motor vehicles and for other purposes." Brolt, Ltd., and W. Holt. December 28th, 1921. (Addition to 178,976.) (191,278.)
34,944. "Electric circuit breakers." British Thomson-Houston Co., Ltd. (General Electric Co.). December 29th, 1921. (191,280.)

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261. "Coupling and braking devices for railway, tramway, and like vehicles." O. Schmidt. January 4th, 1922. (191,286.)
2,235. "Electrically-driven syrens." Efandem Co., Ltd., and J. Eaton. January 25th, 1922. (191,290.)
2,400. "Protective devices, such as lightning arresters." British Thomson-Houston Co., Ltd. (General Electric Co.). January 26th, 1922. (191,293.)
2,859. "Dynamo-electric generators." W. L. Lorkin, E. E. Daglish, and H. B. Swift. January 31st, 1922. (191,297.)
3,449. "Indicators for ships' electric signal and similar lamps." T. Harrison. February 6th, 1922. (191,299.)
5,758. "Electric furnace for the production of calcium hydride (Ca H_2)." A. Kieselwalter. March 3rd, 1921. (176,354.)
7,008. "Synchronous motors for the electric drive of clockworks." R. Michl. March 9th, 1922. (191,313.)
8,248. "Electric insulators." M. F. H. Gouverneur. April 7th, 1921. (178,095.)
12,632. "Lightning protection." L. Vogel. May 20th, 1921. (180,316.)
13,928. "Locking devices for levers controlling railway, tramway, and similar signals, and for other like purposes." F. Downes, C. J. Cooke, D. Rogers, and General Electric Co., Ltd. December 17th, 1922. (191,328.)
16,075. "Current-collector bow for electric vehicles, with turnable carbon slip piece." C. Conradty (firm of). February 13th, 1922. (191,334.)
16,796. "Electric incandescent arc devices." British Thomson-Houston Co., Ltd. (General Electric Co.). June 17th, 1922. (191,337.)
17,162. "Process and apparatus for the transformation of the crystal structure of drawn wires of refractory metals, such as tungsten or the like." General Electric Co., Ltd. July 13th, 1921. (183,119.)
21,250. "Controllers for electric motors." Igranic Electric Co., Ltd. (Cutler-Hammer Manufacturing Co.). August 3rd, 1922. (191,342.)